Claremont McKenna College

The Past and Future of Migration, Poverty, and Small-Scale Agriculture in Mexico

Submitted to

Professor William Ascher

By

Kimberly Zamora Delgado

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ABSTRACT

The conflated pattern between poverty, rurality, and indigeneity in Mexico signifies drastic inequality between populations. Poor, rural communities often do not receive as much public services, infrastructure improvements, and employment opportunities as urban areas, which causes out-migration into the cities. Some of the few jobs available in rural areas are in the agriculture sector, either through small-scale subsistence farming or seasonal employment on a large-scale farm. Historically, certain wealthy states such as Sinaloa, Michoacán, and Sonora received greater support to up-scale into modernized agriculture, which made them into the largest agro-exporters. On the other hand, poor states with greater indigenous and rural populations do not have access to markets and are forced to abandon their livelihoods. Without proper support through financial incentives and agricultural subsidies, the economic welfare of small-scale agriculture will continue to secede along with domestic food security. Adapting to the challenges of climate change by implementing climate-smart, organic, agroforestry, and modernized traditional agriculture these communities can move into sustainable productivity. The combined resources and policies from local, state, national, and transnational entities are analyzed as a prospective method to ensure the livelihoods of these communities.

Key words: Climate migration, climate-smart agriculture, food security, indigenous livelihoods, rural poor, small-scale agriculture

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PART I: Introduction

Chapter 1: Conflation of Poverty, Rurality, and Indigeneity in Mexico

Poverty rates in Mexico have extreme disparities among different regions of the country, despite anti-poverty efforts in the last decades. Although poverty rates have been greatly dissipated, with extreme poverty decreasing by more than thirty percent from 2010 to 2016, the inequalities are still persistent (Silva et al. 2018; Ornelas 2019). A person categorized in extreme poverty has three or more social deficiencies (quality of living, access to health services, education lag, and social security etc.) and lacks sufficient income to fulfill their breadbasket. Meanwhile, a person experiencing poverty, not extreme poverty, has at least one social deficiency present, and they do not have sufficient income to satisfy their needs (CONEVAL 2022). A few Mexican states stand out with the most extreme poverty rates such as Chiapas, Guerrero, and Oaxaca at 29.7 percent, 26.8 percent, and 23.3 percent, respectively (INEGI 2020c; Ornelas 2019). These high poverty rates are an accumulation of various factors that influence the lack of increased poverty alleviation. The effects of globalization have exacerbated poverty and inequality in developing countries like Mexico, where the wealth gap is increasing, and the living conditions are contrastingly unequal (Lara-Ponce et al. 2017).

It is important to distinguish relative poverty from absolute poverty, since the Mexican states with large extreme poverty cases are most similar to absolute poverty cases. This absolute poverty is defined as “below a set line of what is required to access

minimum needs for survival", such as living off of two U.S. dollars a day (Rohwerder 2016). Obviously, relative poverty does not involve contrasts among countries. Another valuable distinction for this study is the distinction between poverty and inequality, where inequality refers to disparities among individuals and across areas (Rohwerder 2016; UNDP 2013). These disparities can include income, education, and so on; therefore, anyone, not just low-income individuals, can experience inequality (Paes de Barros et al. 2009). Although inequalities among different communities in Mexico will be discussed, through gender, age, race, education, etc., the focus will be around people experiencing poverty.

An intersecting issue with poverty is the rurality of a community, where a fuzzy dichotomy exists between rural and urban areas (Flores and Glez. 2015). By the National Institute of Statistics and Geography (INEGI) standards, a population is considered rural if there are less than 2,500 inhabitants and urban is more than 2,500 persons. Keeping in mind that of the over 192,000 municipalities in Mexico, more than 97 percent of them are considered rural communities (Ornelas 2019). In 2016, six out of every ten individuals in rural areas were considered poor, whereas in urban areas it was four out of ten. When it comes to extreme poverty in rural areas, it exists at 17.4 percent, about 13 percent higher than in urban areas. The effects of geographical isolation and inaccessibility to these small rural communities are compounded with the lack of economic and social infrastructure, such as roads and public services (Silva et al. 2018; Ornelas 2019; Flores and Glez. 2015). Therefore, rurality could be seen as a contributing factor for migration outside of these underdeveloped areas.

The states with higher poverty rates and increased rurality also happen to have greater indigenous populations compared to those with lower poverty rates. According to INEGI, the state with the highest indigenous population is Oaxaca with almost two thirds of persons from indigenous descent, with Yucatán (65.4 percent), Campeche (44.5 percent), Quintana Roo (44.4 percent), Hidalgo (36.2 percent), Chiapas (36.1 percent), Puebla (35.3 percent), and Guerrero (33.9 percent); all having a third or more of their population from indigenous descent (Schmal 2015; INEGI 2020a). The 2015 INEGI indigenous survey question involved ethnic self-identification, where people were asked "De acuerdo, con su cultura, se considera indígena?" ("According to your culture, do you consider yourself indigenous?"). Recognizing indigenous populations for this thesis is important, as they are often not recognized in policies that help fulfill their needs and challenges, despite their agricultural contributions in Mexico (FAO 2016). They are the communities suffering the most from land appropriation due to globalization's impact on expanding commercial agriculture.

Another question in the INEGI survey that highlighted the erosion of cultural and linguistic fabric among indigenous peoples in Mexico is indigenous fluency. If one answered yes to the ethnic self-identification question, then the survey asked if they speak an indigenous language (INEGI 2020a). The results showed only eight Mexican states had indigenous populations with 10% or more speaking indigenous languages (Schmal 2015). Thus far, these languages have survived to a certain extent because of indigenous people's physical isolation or avert rejection to the assimilation of Spanish. Yet, the proportion of Mexicans who speak indigenous languages has been declining over

time. With respect to the economic status of the indigenous people, 77.6 percent suffered from poverty in 2016, and 34.8 percent from extreme poverty (Ornelas 2019). Furthermore, out of every 100 agricultural workers, 24 of them speak an indigenous language (Soto 2020). This further supports the fact that Mexico's indigneous populations are some of the poorest and most marginalized identities.

Declining small farms, especially in the Southern states of Mexico, is a pressing issue as indigenous knowledge, traditional agricultural techniques, and agrobiodiversity is lost. Overall, in Mexico the average age of a farmer is increasing, as younger generations either leave or move into larger rural communities or small cities to seek alternative forms of income (Silva et al. 2018). The population working in the agricultural sector is also decreasing. Since oftentimes in these small farming communities' individuals are not paid a wage, especially among women, they are forced to seek wage labor elsewhere. National remittances are "mostly sent by working members of poor rural households who are away temporarily" (Escobar 2020). This migration could be due to periods of economic and social uncertainty, where nearby larger communities are a reasonable choice instead of migrating to further locations like the United States. Furthermore, few policies and regulations exist for rural communities that are in dire need of public services, markets, and employment access, which could mitigate the need for outsourcing employment (Silva et al. 2018; Ascher 1995; Hernandez-Perez 2019). Therefore, these migration patterns are sometimes out of necessity, not so much out of personal choice.

Even though the agriculture sector only contributes less than four percent of the nation's Gross Domestic Product (GDP), it employs over 13 percent of or over seven million of the working population (FAO 2016). Small or family run farms are often held by communal land ownership called ejidos, that are difficult to sell. Although ejidos were originally meant to redistribute land to peasant communities, it was largely inefficient until 1992 where ejidatarios and their family were given more land-use rights (Silva et al. 2018). This allowed increased privatization, sale and rent of the land, which has had mixed effects depending on the ejido community (Escobar 2020). Now, around 15,500 ejidos exist with the average being at least 200 hectares of forested land, with indigenous agrarians owning 28 percent of forested land and half of the forest in ejido property (Silva et al. 2018). This natural resource access, but lack of institutional land rights, puts these indigenous or small-scale farmers in difficult situations. Their land is constantly under threat, as they are under pressure to sell their lands to other large landowners (UNCTAD 2013; Lara-Ponce et al. 2017). Moreover, producing crops has become increasingly expensive for these small scale ejidos despite government subsidies. Lacking the ability to utilize public services, commercialize their crops, or apply for credit through banks, these farmers cannot benefit from their investment of the land. Land loss due to the absence of programs and policies that protect indigenous land patrimony, also causes the displacement of these communities (UNCTAD 2013; Lara-Ponce et al. 2017).

Meanwhile, the few modern farms, typically established in the Northern areas of the country such as Jalisco, Sinaloa, and Tamaulipas, focus on monocultural farms with the use of advanced technologies and irrigation and provide for global exportation and

national needs. But even modern farms have recently been struggling as drought has been hitting the country worse every year (Lara-Ponce et al. 2017; Penniman 2015; World 2014). Yet, the productivity gap between large and small farms takes a toll on small farmers who cannot compete with these larger producers, who can afford innovative strategies and machinery (Silva et al. 2018; Escobar 2020; FAO 2016). However, the Food and Agriculture Organization of the United Nations recognizes that small-scale farming in Mexico with increased investment is capable of promoting economic growth, reducing poverty and inequality, and improving food security.

The compounding factors of extreme poverty, language barriers, and land access further influence inequalities for these community members who have little transferable skills and seek employment elsewhere. Emigration differences among Mexican states are dependent on a variety of facets, including work opportunities, natural disasters, violence, or improved quality of life. Some migrants move temporarily, others permanently (Escobar 2020). The states of Chiapas, Guerrero, and Oaxaca rarely have individuals born from another country or state, implying that few migrate into these states (INEGI 2020b). Since these rural farming communities and individuals in Mexico have had to emigrate to other areas, such as small or larger cities (urbanized areas) to survive, some of those individuals have ended up worse off due to this forced migration (Kumari et al. 2018). Some of the conditions that characterize a worse situation is mistreatment from others in the city through discrimination, pressured to live in the city's poverty-stricken areas, hollowed out families or declining agricultural production back on the farm (UNCTAD 2013).

Since agriculture has remained a backbone for rural Mexicans, especially indigenous Mexicans, their way of life is under threat. Indigenous peoples hold the utmost importance to their connection to land and how they interact with it as a "patrimonial base" (Penniman 2015; Lara-Ponce et al. 2017). As the FAO discusses, familial agriculture in Mexico is a cultural space and way of life, where families want the necessary and dignifying conditions to live (Hernandez and Santos 2006). The previous statistics further display how demographic disparities align with poverty and agricultural disparities, in which indigenous people live in some of the poorest and most isolated areas of the country. Small-scale farmers will have the most impactful losses due to climate change (Kumari et al. 2018). Therefore, the rise in inequality because of reluctant migration could just be an economic consequence of moving away from agricultural markets to more industrialized markets. This reluctant migration is made by people who would have preferred to remain were it not for deteriorating conditions. These migrations should come with opportunities for a better life for indigenous and agricultural workers, where these aggregating inequalities provide political motive for improved provision for these individuals.

The rural to urban migration issue is also an environmental issue, since changing environmental systems can be one of the contributing factors for certain internal migrations. As climate change has become increasingly impactful on agriculture viability, it has also prompted climate migration and displacement. According to the World Bank, "internal climate migrants" in Mexico are estimated to be between 200,000 to over 3 million people by 2050, around 0.80 to 1.23 percent of the Mexican population,

depending on the inclusivity of climate friendly policies (Kumari et al. 2018). Mexico is one of various developing countries having to address the issues that come with climate migration as spontaneous natural disasters can be a major cause for migration, but other factors also contribute. These include but are not limited to extended drought, sea level rise, irregular weather, resource scarcity, loss of biodiversity, etc. Location is also important as specific regions, such the dichotomy of the Northern and Southern Mexican climate system and agriculture, affect one's decision to migrate. Out-migration will predominantly come from rural, lowland areas in Southern Mexico, as people move into the Central Plateaus and highlands where agricultural viability is greater. Similarly, in-migration to cities such as Mexico City will increase and out-migration from Nuevo Leon and Jalisco will increase due to inaccessibility of water and deteriorating crop productivity (Kumari et al. 2018). Considering that climate change impacts are expected well into 2100, the number of climate migrants are expected to increase (IPCC 2021).

Migration induced by climate change has shed light on other serious environmental problems, such as declining agricultural productivity due to over exploitation. The degradation of agricultural lands is of utmost concern, as soil nutrients depleted from overuse produce lower yields into the future (FAO 2016; Penniman 2015; World 2014). This could also exacerbate other humanitarian crises such as poverty, livelihoods, and hunger as explained earlier. With little protections and provisions for individuals most burdened by the effects of climate change, they are the most negatively impacted and vulnerable to these increased inequities. Although the severity varies across Mexican states and regions, the issue can be observed throughout Mexico and other parts

of the world (Kumari et al. 2018). Policies that recognize the implications of environmentally driven migration at least should be implemented to make the transition of migration easier.

Policies to mitigate the effects of irregular or extreme climate, such as improved irrigation, regenerative agriculture, organic farming, "campesina-familiar", and climate smart agriculture, are important to consider as a means to reduce "Green Revolution" agricultural failures. Organic agricultural systems have surfaced as a mode for market opportunities for small-scale farmers, for example through organic coffee exports. Around 3 percent of Mexico's exports are organic, which are mainly fruits and vegetables, but their high prices often make organic food inaccessible for domestic consumption (UNCTAD 2013). Mexico's national Law on Organic Production makes it one of the few countries with specific requirements and regulations for organics (Gonzales-Esquivel 2017; Quesada 2006). Other modes of conservation common in climate-smart agriculture, such as composting, manure fertilization, efficient use of pesticides and herbicides, and soil restoration, can enhance the resilience of the land and reduce greenhouse gas emissions (Hernandez and Santos 2006; Hernandez-Perez 2019). Meanwhile, campesino or traditional farming is the precedent to these more modern practices, as community and cultural values are additionally embedded into indigenous agriculture. These techniques can combine the traditional and sustainable agricultural systems, fostering farms adaptive to climate change.

The effect of climate change on arid and semi-arid regions of Mexico differs from the coastal, plateau, and tropical areas. In the past 50 years, Mexico has warmed almost

one degree Celsius, and precipitation has dropped by over 36 centimeters, with northwestern arid states and northern Yucatán suffering the most changes into the future. Projected climate trends include more frequent tropical cyclones, because of more extreme El Nino's; and sea level rise, especially along the Gulf of Mexico, which will cause the loss of almost 20,000 square kilometers of land between 2050 to 2100. Meanwhile, crop productivity is expected to drop ten to 30 percent in coastal areas, while the central plateau will experience a crop productivity increase upwards of 50 percent (Kumari et al. 2018). Therefore, adaptation to climate change, based on regional challenges, is necessary for effective policy implementation.

Through a comparative public policy analysis of different states in Mexico, solutions to mitigate, prevent, or improve the state of living for these climate migrants will be discussed. Often, the perceptions of "rural", "indigenous", "agricultural", and "low-income" populations are conflated in Mexico. The multifaceted issues of poverty, climate change, and food security intersect with these populations, as climate migrants become more common. States that are similar in emigration, Gross Domestic Product (GDP), poverty alleviation, and agricultural demographics, work as a comparison should be between states undergoing similar issues and challenges. They were also chosen based on percent of indigenous peoples, who more often face the decisions between migrating or not. Revolving around the intersectionality of these issues, an analysis is conducted about how these Mexican states have reacted to climate migrant issues and advise different government entities on what they can do to maximize the wellbeing of their people.

Chapter 2: Dynamics of Agriculture Policy

In pre-Hispanic times, diverse crops were utilized by indigenous communities for food security, culture, tradition, and medicine (Parragues-Vergara et al. 2018). "Ecological imperialism" by the European colonists, who introduced animals and plants for cultivation, which was the start of a transformed agricultural landscape (Melville 1994). This was the beginning of the abandonment of traditional agriculture. Then, the post-independence agricultural revolution in Mexico brought about agrobiodiversity in crop productivity and increased exports. In order to promote agricultural productivity, land reform passed in 1857 which stripped the land from some of these indigenous and smallholder communities. Because of land loss and large-scale agriculture competition, indigenous people lost hold of their land and agriculture practices to large landholders, especially in the states of Yucatán, Morelos, Chiapas, and Oaxaca (Escobar 2020). The extinction of certain traditional crop breeds such as Creole maize used by Mayan and Mestizo communities, or the decline in practice of agroforestry and milpas, has made clear the deterioration of indigenous agriculture (Lara-Ponce et al. 2017; Garcia et al. 2021). The conversion to pastoral farming land also prompted environmental degradation through deforestation and overgrazing. Colonization sparked the beginning of different land management techniques and a changing environment in Mexico that resulted in the decline of indigenous culture (Melville 1994).

From the 1940s to the 1960s productivity multiplied fourfold, as a result of the Green Revolution that implemented large, technified farming. This was accomplished

with modernization of the agricultural sector, including agro-industrialization through the Rockefeller Foundation Mexican Agricultural Program (MAP), as part of the "Green Revolution" the Mexican and U.S. government promoted (Hernandez-Perez 2019; Escobar 2020; Hewitt de Alcántara 1978). The goal of industrializing agriculture was to move away from "primitive" characteristics placed on developing countries (Astier et al. 2017). This initiative boosted food supply, such as beans, corn, avocados, and so on. Corn and wheat production also grew by millions of tons, as by 1974 the U.S. and others were receiving surplus cereals from Mexico (Escobar 2020). Certain agricultural sectors that boomed were sugar, coffee, and cacao, as certain states such as Sinaloa, Tamaulipas, and Jalisco were heavily invested in during the 1960s through irrigation technology, pesticides, and fertilizers. Despite increased development efforts in dam-building, electricity, and transportation, smallholder and indigenous communities were left behind in infrastructure improvements. Crop production intensification also followed with increased prices of land, where small-scale or indigenous community farms could not compete with the large-scale farms. This process of globalization has therefore mostly benefited large landholders and has left behind traditional farming practices.

The 1960s and 70s saw waves of support for local knowledge and small, traditional farming practices, as the benefits of modernization were questioned. From this agricultural revolution, the rise of hybrid seeds and varieties along with agrochemicals sparked controversy among agronomists (Astier et al. 2017). A search for alternative forms of development and practice turned to indigenous agricultural systems, such as chinampas and ancient agro-silvo-pastoral systems (Rosado-May 2016). These

small-scale practices, although less profitable than large-scale, proved to provide more ecosystem services, natural fertilizers, and robustness to climate and disease. By the 1980s and 90s, numerous disciplines and research in agroecology and ecology were created in opposition to the Green Revolution, as promoted by the National Institute for Biotic Resources (McClung de Tapia 1990).

Agroecology combines indigenous knowledge and culture with Western science in order to promote more sustainable practices and strengthen local markets (Astier et al 2017; FAO 2022). The Latin American Scientific Society of Agroecology, established in 2007, now provides initiatives geared towards sustainable development while prioritizing food sovereignty, agrobiodiversity, and natural resource conservation (Wezel and Soldat 2009). Agroecology is a basis for biocultural conservation, in which the loss of culture, coupled with the loss of biodiversity, drives conservation initiatives (Gonzales-Esquivel 2017; Bridgewater and Rotherham 2019). The importance of food sovereignty is tied to such concepts. First proposed during the World Food Summit of 1996, food sovereignty highlighted the need for healthy and culturally relevant foods "through ecologically sound and sustainable methods, and [people's] right to define their own food and agriculture systems" (Parraguez-Vergara et al. 2018; Nyéléni 2007). The importance of these concepts will be highlighted later in this thesis, as this shift in agricultural ideology represents the tensions between small- and large-scale agriculture.

Since agricultural products remain highly exported, the availability of agricultural land for domestic consumption has been impacted (Astier et al. 2017). This food is often produced in small-holder farms of less than five hectares, making farmworkers and farm

owners in Mexico vital for the continuation of exports. Around three-fourths of exports are directly to the United States, with other large markets in Europe, Canada, and Japan, adding up to 90 percent of total agricultural exports (UNCTAD 2013). Between 2016 and 2018, imported agricultural goods to the United States from Mexico was an annual $24.5 billion (Martin 2020). Some of the highest exporting states are Sinaloa, Jalisco, Michoacán, and Sonora, with non-traditional export zones growing in Puebla, Zacatecas, San Luis Potosi, and Baja California Sur (Escobar 2020). Mexico is the primary global producer of avocados, lemons, and limes, and among the top five for grapefruit, maize, beans, coconut oil, oranges, and poultry (FAO 2016). These products have crowded out various common crops such as beans, maize, rice, and wheat, whereby Mexico has instead increased their imports of such foods by 200 percent since the 1990s (UNCTAD 2013). The technified agribusiness in Mexico has boosted economic development, but at the expense of decreased agro-biodiversity and traditional agriculture (Parraguez-Vergara et al. 2018). Therefore, domestic markets have suffered in competition to international markets.

Compared to other countries, Mexico has various trade agreement policies that have benefitting mostly large, modern farms, while punishing traditional, small farms. One of the most impactful agreements is the North American Free Trade Agreement (NAFTA) of 1994, which removed tariff and non-tariff barriers between Canada, United States, and Mexico. The agreement has undergone changes, but the most concerning effect in terms of production has come from non-tariff measures in food quality and safety, making Mexico's agri-food industry more expensive. On top of that, Mexico has

enacted their own food safety policies such as the General Health Act and the Plant Production Law to meet the USDA regulations (UNCTAD 2013). Since large farming oligopolies already have the upper hand in gaining subsidies from the Mexican government, NAFTA greatly limits trade to these farms that can afford the additional costs of production. Meanwhile, high U.S. subsidies for maize, rice, and wheat (highly imported products in Mexico) have caused less domestic investment and productivity of such crops, despite their significance in cultural foods (Hernandez-Perez 2019; UNCTAD 2013).

Programs for indigenous and rural communities have been implemented in the past decades, recognizing their economic and social needs. In 1992, a nationwide agrarian reform promoted investment in rural communities to combat poverty and the marginalization of small landholders (FAO 2016). Five years later, the Conditional Cash Transfer (CCT) Program allowed low-income families monthly financial assistance as long as their children are enrolled in school and receive healthcare. One sweeping program was the 2013-2018 Sectoral Program for Agricultural, Fisheries and Food Development that outlined a variety of policies concerning improved sustainability, productivity and food security. Further efforts to eliminate hunger in extremely poor communities was the national *Sin Hambre* Program 2014-2018, which also included increases in food production and transfers to farmers (FAO 2016). Despite these broad efforts to alleviate poverty in rural areas, many populations still suffer malnutrition, food insecurity, and lack of public resources.

In the past decades, Mexican government leaders have recognized the damaging environmental effects of booming agricultural production on the land. The degradation and salinization of soils, greenhouse gas emissions, overexploitation of water sources, pesticide and insecticide pollution, and other damages have promoted other climate stressors such as drought. From 2007-2012 and 2013-2018, the Mexican government has promoted a series of National Development Plans (NDP) to address such environmental challenges (FAO 2016). One was the Special Climate Change Program in 2009, with initiatives including cutting greenhouse gas emissions in half by 2050, assessing climate change vulnerability, and other pollution-mitigation strategies like efficient electricals and renewable resources. However, challenges in water and energy overexploitation, due to 60 percent subsidies on irrigation systems in agriculture since 2002, have yet to be addressed.

Chapter 3: Alternative Forms of Agriculture

Climate-smart agriculture calls for avoiding tilling, using crop rotations, implementing efficient irrigation, enhancing climate resilience, and other approaches to sustainably maximize production, in the face of climate change. CSA focuses on the three pillars of productivity, adaptation, and mitigation, in which farmers weigh the tradeoffs between sustainability and climate resilience. Pesticides and herbicides are used sparingly with organic fertilization. Another tactic CSA considers is reducing greenhouse gas (GHG) emissions when possible, which is especially important as agriculture makes up about a third of GHG emissions (World 2014; FAO 2021)**.** The FAO supports CSA because it is aligned to their recent Strategic Framework 2022-2031, following "better production, better nutrition, a better environment, and a better life for all" (FAO 2021). Strong financial and government institutions are necessary for such changes and initiatives, but Mexican states like Sinaloa are in the process of scaling up their CSA through federal support in loans and insurance (World 2014). Rhetorically, advocates for CSA invoke inclusivity as a vital aspect of CSA and the Strategic Framework since the most vulnerable to climate change are small-holder or indigenous farmers. Ideally, CSA would prioritize site-specific policies with the involvement of all stakeholders and local knowledge in the development of these policies (FAO 2021). Although CSA advocates would argue this would be a potential solution to climate change without ignoring self-security, the end goal of CSA is maximizing production, which has contested criticism in comparison to organic or regenerative agriculture.

Advocates of organic agriculture often claim that organic fertilizer, cover crops, and crop choice, boost soil fertility and integrate biodiversity and ecological health. Organic agriculture arose due to concerns in the safety and sustainability of conventional agriculture that is driven by high intensity productivity and input . Ecosystem maintenance is key in organic agriculture, as the natural areas are conserved to aid in energy cycling and pollination to reduce natural resource degradation and pollution (FAO 2021). In Mexico, the most common organic crops are coffee, fruits, vegetables, and cacao, with small-scale farms growing most of these crops (UNCTAD 2013). Organic farming greatly reduces the use of agrochemicals and instead diversifies crops, grows cover crops, and does not use transgenic/genetically-modified crops. The restoration and conservation of soil is crucial to organic agriculture to secure disease control and promote carbon storage. Although organic farming has received some backlash against the viability of increasing agricultural outputs, higher yields are often experienced in small-scale or traditional farms rather than conventional farms **(**FAO 2021). Like CSA, these strategies will create resilience against climate change.

A stricter alternative to climate-smart and conventional agriculture is regenerative agriculture, which focuses minimal use of fertilizer and pesticides in order to improve soil health and restoration to promote carbon sequestration. There is no one way to practice regenerative agriculture, however, the movement arose in the 1980s due to issues with over-tilling, overgrazing, and overexploitation of farmlands. The consequences of such actions result in poor soil soil, low in nutrients and microbes that are the building blocks of life in soil. Common practices are drill seed technology instead of tillage, cover

crops, crop diversity and rotation, and reduced agrochemical usage. Regenerative agriculture can integrate livestock, for which manure and grazing are used on a rotational basis (Ranganathan 2020; Newton et al. 2020). Although advocates claim regenerative agriculture could mitigate climate change, the scalability of soil carbon sequestration and uncertainty of organic matter breakdown still has some questioning the potential of long-term carbon storage. One of the only certain claims is that regenerative agriculture can restore soil health (Ranganathan 2020; Bradford et al. 2019). Without a formal definition for regenerative agriculture, specific policies and standards are challenging to develop and implement; however, a prospective element is the emphasis on soil health, which has the policy potential to be more widely incentivized (Newton et al. 2020).

A variant of regenerative is conservation agriculture (CA), which emphasizes minimal soil damage and protection, but does allow the use of synthetic agrochemicals (Conservation 2015). Under CA, zero to minimal tillage is implemented as a means to reduce soil disturbance, boost infiltration, and allow soil organic matter build-up at the surface, which models a system of a forest. Chemical and organic fertilizers are only used if necessary for additional nutrient supply. Most adoption has occurred in small-scale farms in developed and developing countries, but the greatest barrier is often access to technology. Although there are mixed results in yields, advocates claim declines in yields are usually due to lack of land management knowledge from novice farmers and experience. However, soil conditions at the beginning of the CA transition, as well as increased weed and pest problems during the transition, will largely dictate how long it will take for yields to improve. Over time, though, soil erosion will dissipate, GHG

emissions are reduced, and microbial activity and biodiversity are enhanced, which could foster a more sustainable system. Other observed benefits include decreased labor and resource inputs along with increased yield outputs, which could be especially beneficial to small-scale farmers with restricted access to resources and land (Conservation 2015).

INDIGENOUS and TRADITIONAL AGRICULTURE

Indigenous agriculture relates to organic and CSA farming as it brings the localized perspective and cultural practices may have the potential to conserve both tradition and ecology. The stigma behind poverty in rural areas is tied to traditional knowledge, as indigenous groups have sometimes shifted to modern agriculture, no longer aimed at self-consumption. This leads to the undervaluing and abandonment of traditional knowledge. Important elements found in various traditional agricultural practices in Latin American countries are the influence of culture, protection of land, native crop use, and natural resource conservation. Since many of these traditional farms are adapted to the local climate, native seeds have stronger resistance to seasonal changes and disasters, such as drought, disease, or storms, while some hybrid or transgenic seeds require more agrochemicals and infrastructure. However, global climate change may challenge this resistance. Akin to CSA and organic farming, many traditional techniques use intercropping, natural pesticides, slope protection, and biocultural diversity (Parraguez-Vergara et al. 2018; Lara-Ponce et al. 2017). Examples of traditional systems include the Mayan milpa, agroforestry, cafetal, and chinampa, some still applied today. The traditional systems of milpa, cafetals, chinampas, and the now modern term of agroforestry/agroecosystem, incorporate similar practices of intercropping and soil

health, often seen in more indigenous states such as Chiapas and Oaxaca. Modern sustainable agricultural initiatives have also been advancing in various indigenous communities such as organic agriculture in Chiapas (Martinez-Torres 2008), sustainable agriculture in Mixteca Alta and Campeche (Boege and Carranza 2009), and climate-smart agriculture in Sinaloa (World 2014). The conservation of traditional agricultural knowledge is vital for the survival of the broader culture of these indigenous groups, and as climate change brings about unforeseen challenges, sustainable agriculture could help these communities to maintain their incomes and general well-being.

The traditional milpa system, which had been used widely across Mesoamerica for over 3,000 years combines rain-fed maize, beans, chiles, and squashes, a form of intercropping, emphasizing cultivation and fallow periods for sustainability. Milpa cycles typically follow a two year cultivation period initiated by burning small areas to release nutrients back into the soil, followed typically by an eight year fallow period, where annual crops are rotated alongside perennial shrubs and trees to re-establish mature forest for the future. Some milpa systems are organized so the maize is on the top story, with beans in the middle, and squash on the floor; this diverse planting structure allows for minimal soil erosion and weed growth (Penniman 2015). To go along with traditional milpa crops, indigenous people also intercrop gourd, bean, string beans, and pigweed (Hernandez and Santos 2006). Since the milpa system is labor intensive, involves low fertilizer inputs, and the yield per unit of area is low, it continues to run the risk of being overrun by high-intensity agriculture, where farmers have adopted shorter fallow periods, agrochemicals, and less diverse crops (UNCTAD 2013; Garcia et al. 2021). The falling

prices of maize due to globalization have made revenues decline below domestic production costs for many farms, in turn increasing maize imports (Garcia et al. 2021). Different variants of milpa have emerged as a way to adapt to the land, which could aid in reducing deforestation and migration. By adopting the milpa system to fit sociocultural needs as well as adapting to climate change challenges, traditional systems could persist in these indigenous communities.

Lesser used systems like cafetal and chinampa also have a history of promoting agrobiodiversity. Cafetal is an traditional system optimal for coffee plantations, where “shady, multistory system with tall…guajinicuiles and fruit trees" grow above coffee trees in the middle, which also provides shade for understory growth of chiles, chives, and chayotes (translates to mirliton squash) (Penniman 2015). This system fosters the cycling of nutrients by retaining soil moisture and nitrogen, and has been shown to increase protection against disease, biodiversity conservation, and other ecosystem services (Perfecto et al. 2010). Chinampas, an Aztec system of long garden/farm islands built on shallow freshwaters, are considered one of the best agricultural techniques ever created because of its high year round productivity (Penniman 2015). This raised bed technique was primarily abandoned due to political and economic turmoil among ancient indigenous cities, and now very few areas such as Xochimilco still practice it (Morehart and Fredrick 2014; Vera 2018). Flood prone or marsh areas are ideal for chinampas, but there is little access to markets from them currently, so it is largely abandoned (Vera 2018). Although these systems are less common, some of their sustainable strategies could still be adopted where appropriate.

Implementation barriers to CSA and organic agriculture in traditional Mexican farms are the lack of widespread private ownership or tenure to land and weak policy support (FAO 2021; Ascher 1995); therefore, multiple groups and organizations supporting the advocacy and assistance to indigenous and small-scale farms in Mexico have formed in the last few decades. The Exchange, Dialogue and Advisory Program on Sustainable Agriculture and Food Sovereignty (PIDAASSA), composed of 15 organizations in other locations like Ecuador and Peru, has fostered the recuperation of traditional practices combined with agroecology and is recognized as an organization led by campesinos, for campesinos. The Center for Integral Campesino Development of the Mixteca (CEDICAM) is one of these organizations, which has aided campesino/traditional farm owners and workers to promote sustainable farming in the Mixteca region of Oaxaca since 1983. Working against the modernization, globalization, and free market trade of agriculture, CEDICAM teaches campesinos how to improve their productivity and agroecology while incorporating local and indigenous knowledge (Hernandez and Santos 2006). The coordinator of CEDICAM, Jesus Leon Santos, has encouraged practices to prevent erosion such as trenches and terraces with robust local vegetation, and restores deforested hillsides with native nitrogen-fixing trees (Penniman 2015). This is especially important for the Mixteca Oaxaquena region that covers the states of Puebla, Oaxaca, and Guerrero, which is threatened by deforestation, urbanization, and emigration (Hernandez and Santos 2006). In order for sustainable agriculture to combat climate change it must be accompanied by traditional practices that are adapted to local conditions and challenges.

Chapter 4: Climate Migration

On an international scale climate migration has been recognized as an issue, but the official title of "climate refugees" has yet to be adopted. Since there is little international or even national protection under the law, these climate or environmental migrants do not qualify for support because of reluctant migration. The working definition for environmental migrants, according to the International Organization for Migration, are people who leave their home either temporarily or forever due to "sudden or progressive" climate stressors such as floods, drought, typhoons, and more (Kumari et al. 2018). Until 2018, under the Global Compact for Safe, Orderly, and Regular Migration (GCM), international climate change and natural disaster migrants were recognized. Although displacement and climate migration might be considered negative, migration in other contexts is not necessarily bad. However, those migrating across states and cities in Mexico are often the poorest and most vulnerable, and are not provided assistance since they are migrating internally. Although the displacement of climate migrants cannot be considered "climate refugees", as it could undermine the current definitions and qualification of a refugee, perhaps in the future it could be incorporated under the umbrella as climate stressors become more extreme (Podesta 2019). For Mexican climate-stressed migrants, the country should instead focus on providing aid and resources to them depending on the severity and duration of their displacement.

Addressing climate migration in Mexico is an urgent issue, as over 100,000 new displacements occurred in 2020 alone, according to the Internal Displacement Monitoring

Center. Upwards of 2.1 million climate migrants are expected by 2050 in Mexico and Central America, which does not include internal migrants, who are largely disregarded from provisions available to international migrants (Kumari et al. 2018). Meanwhile, migrant workers in Canada and the United States have the 3x1 Program, the Seasonal Agricultural Worker Program (SAWP), and others (Milan et al. 2016). Some of the serious weather events that prompted this displacement include Hurricanes Delta, Eta, Zeta, and Genevieve as well as wildfire in Hidalgo, Tropical Storm Gamma, Hanna, and others (IDMC 2021). These events cause resource scarcity of clean water and food, and, without social networks that create permanency or protection, even more are drawn to migrate. Other migrants may move cyclically away and back, which lessens the impact they could have on their home communities. Labor opportunities may exploit migrants and force them to accept low-wage, low-skilled jobs. Therefore, to adapt or reduce out-migration from rural areas, a multifaceted approach is needed to consider the advantages of remittances and government support (Milan et al. 2016).

Current disaster relief policies in Mexico have been gradually improving the consideration for aid, especially for small farmers. In 2003, the Component for the Attention of Natural Disasters (CADENA) Program was offered to states as a means to provide compensation coverage to small farmers who have undergone major natural disasters (FAO 2016). The budget for the program grew to US$303.8 million from US$8.4 million in ten years, as it has expanded to almost all states and has overall succeeded in reaching eligible farmers. Another 2003 provision targeting small and medium grain and oilseed farms was the Target Income Programme (Incentivo

Complementario al Ingreso Objetivo), which gave a minimum income that adjusted to market prices. In order to reduce food waste, redistribute food, and provide income to small farmers, the Rural Supply Programme (Programa de Abasto Rural) buys "food at minimum fixed prices" from marginalized rural farmers and food-insecure communities (FAO 2016). These programs are steps toward national recognition of the importance of small-scale, indigenous farms and forms to alleviate poverty among these groups.

Although other subsidies and programs are available to farmers, often only medium to large-scale farms obtain these benefits. Unequal access to such programs have forced small-scale farms to keep up with commercialization strategies that are built for mass-production. This intensified production is partly due to increased trade agreements, such as NAFTA, the Pacific Alliance (PA), and the Trans-Pacific Partnership (TPP), to boost economic growth. Another purpose of these pacts is to improve agricultural technologies for irrigation and energy through increased subsidies to farms in order to reduce poverty and strengthen competitiveness and employment opportunities. For example, from 2002 to 2016, electricity subsidies for irrigation have increased to 60 percent for all. However, this has also had environmental drawbacks with the overuse of water (FAO 2016). Also, small-scale farmers are largely excluded from enhanced irrigation technology and therefore subsidies. Larger issues come from the high U.S. subsidies in the United States, where artificially low prices outcompete small-scale Mexican farmers (UNCTAD 2013; Lara-Ponce et al. 2017). Increasing culturally-relevant financial and technical assistance offered by federal and state entities to small-scale Mexican farmers is vital (Parraguez-Vergara et al. 2018).

PART II: Clarifying State Trends

Chapter 5: Modeling Success and Failure in States

To assess state success or failure in alleviating poverty rates, especially among indigenous communities, econometric modeling was necessary for this policy analysis. The demographic variables included for each Mexican state are percent indigenous population, percent emigration population, percent rural population, percent population who speak an indigenous language, and average education level attained. The economic variables are Gross Domestic Product (GDP), GDP per capita, the extent of poverty and extreme poverty. A set of econometric models is created to perform a cross-state, multiple regression analysis at a given time, in this case the 2019 census. The models containing these similar measures of poverty could result in issues with collinearity. Therefore, a correlation matrix of all candidate variables is constructed to find variables with correlations higher than 0.75, which applies to the demographic and economic variables. Major variables that are highly correlated are the proportion of indigenous population and indigenous language with proportions of poverty and extreme poverty: a negative correlation between percent of emigrants and percent poverty; a positive correlation with percent indigenous language and percent rural population; and a positive correlation with percent rural population and both poverty measures. These results match with the patterns discussed in the introduction.

The proportions of poverty, extreme poverty, rurality, and average education level cannot be included as independent variables within the same model, due to this simultaneity bias among the economic measures. Therefore, when constructing the regression model, the highest R-squared value dictated the best model for logGDP per capita, poverty, and emigration as the dependent variable. The purpose of these regression models is to identify which states have high logGDP per capita, lower poverty rates, and emigration levels in relation to other state measurements, holding all else fixed. It is important to note that when interpreting these data, the statistical significance does not matter in this case because the set is the entire universe of cases. It represents all 31 states of Mexico plus Mexico City. Identifying which states have relatively more success with poverty alleviation dictated which states were considered for this policy research.

The first regression model for GDP per capita, which had to be modified for reasons explained later, includes the independent variables of proportion of indigenous population, emigrant population, and average education level attained to achieve the highest R-squared. GDP per capita is also transformed to the logarithmic value to mitigate the effects of extreme values and make the distribution as normal as possible. Using the coefficients and constant of this regression model, a predicted logGDP per capita value for each state is calculated to compare to the actual value. The difference among these values demonstrates whether the state is succeeding (higher GDP per capita) or failing (lower GDP per capita) compared to the rest of the states. The greatest difference in success came from Campeche, known for its petroleum production, while

the greatest difference in failure was Tlaxcala. The states on the verge of success versus failure include Tamaulipas, Aguascalientes, and México City. Some unsurprising success results include Nuevo Leon and Baja California Sur as these are known for being richer states. Some surprising successes include Oaxaca, Quintana Roo, and Michoacán, who have lower GDP per capita on average. Meanwhile, some unsurprising failures are Chiapas, Nayarit, Puebla, and Hidalgo, which are known for their large indigenous populations. Surprising failures are Sinaloa and México City, which are known as economic powerhouses contributing a sizable chunk to the GDP. Although this model attempts to control for other factors that could contribute to GDP per capita, it still is weak in accounting for the results.

The next model predicts poverty levels within states using the following independent variables: logGDP per capita, proportion of indigenous population, emigrant population, and rural population. Successful states represent those with lower actual poverty than predicted, and failure states are vice versa. The top successful states are Yucatan, Sinaloa, Hidalgo, Nayarit, and Oaxaca; while the least successful are Mexico City, Morelos, and Campeche. Other surprising results are Nuevo Leon, Queretaro, and Baja California as failures because, as previously mentioned, these are richer states. Many predominantly indigenous states also succeed except for Quintana Roo, Chiapas, and Puebla. Overall, when compared to the logGDP per capita model results, the poverty rate model success and failures do not always correlate to high or low GDP per capita, respectively. This is important as it reveals the shortcomings of a high GDP per capita

because in actuality the state may have higher rates of poverty than expected, or factors outside of the model can account for this.

A final model is created for predicted emigration to see if states were experiencing more or less emigration than expected. The independent variables include logGDP per capita, and the proportion of indigenous and poverty populations. Again, the difference between actual and predicted emigration values revealed whether there is more or less emigration than expected. The states with more emigration than expected are Queretaro, Nuevo Leon, Quintana Roo, and Baja California Sur, while the ones with the least are Yucatán, Coahuila de Zaragoza, and Sinaloa. Large indigenous population states are a mixed bag, with Hidalgo, Chiapas, and Puebla having more actual emigration, while Campeche and Oaxaca have slightly less actual emigration than predicted. These results help dictate how migration within states varies and what reasons could be contributing to this variation. This points to the fact that increased emigration is not always inherently negative, as it could either signify mobility from tourism, economic factors, or other reasons.

Since the focus of this analysis is to see how indigenous peoples' livelihoods are differentially impacted, another regression analysis is conducted excluding the Mexican states with an indigenous population of less than 9.1 percent. This model excludes the eight states of Nuevo León, Zacatecas, Baja California, Tamaulipas, Guanajuato, Durango, Chihuahua, and Coahuila. Mexico City is also excluded in this model as it could present outlier effects on the data as a densely populated metropolitan area. This

way the effect of states with small indigenous populations is isolated and does not skew the distribution.

Similarly, starting with logGDP per capita as the dependent variable, the independent variables are the proportion of indigenous, emigrant, and poverty populations. This model has a lower R-squared value as it has fewer observations or states. Campeche remains the highest, with Tabasco, Queretaro, and Veracruz moving up from the original model as more successful than predicted. The less successful states are similarly placed relative to the original model, with Yucatán, Sinaloa, Michoacán, Nayarit, and Tlaxcala composing the bottom five states, respectively. Some states that switched from successful to failure were Guerrero, Jalisco, Michoacán, and Oaxaca, while only two states, Morelos and Puebla switched from failure to successful. The rest of the states match in success or failure with the original model results.

With predicted poverty, much of the same results are observed, with the model excluding low indigenous population states. Yucatán and Sinaloa remain the top two states with lower actual poverty rates than predicted, while Veracruz, Campeche and Morelos make up the bottom three states. The only states that switched from success to failure outcomes are Colima, the State of Mexico, and Tlaxcala, which go from failure to success and Hidalgo just barely goes from success to failure (a stark difference as before it was in third place for predicted success). Meanwhile, for emigration Yucatán, Sinaloa, and Sonora remain among the states with the least emigration, and Queretaro, Quintana Roo, and Baja California Sur remain the highest. Only three switches are observed, with

the State of Mexico and Nayarit going from more to less emigration and Oaxaca resulting with more emigration observed with the new model.

The major findings from all of these regression analyses are that migration and poverty rates are not necessarily correlated, and high logGDP per capita does not correspond to lower predicted poverty rates. From the results in both versions of the model for emigration, states that have higher poverty rates do not experience higher migration rates. With or without controlling for other variables, people in poorer states have lower migration rates. This implies that people do not migrate often, which could be due to financial limitations, people wanting to stay with family, or lack of confidence to leave. Since poverty does not necessarily dictate higher emigration patterns, the states surprisingly retain people. Another observation made from both the poverty and emigration prediction models excluding less indigenous states, is that several state predictions stayed consistent all across with less emigration, lower logGDP per capita, and lower poverty rates. These states are Yucatan, Sinaloa, Michoacán, Aguascalientes, and Sonora. Either way, the policies adopted by these states may be appropriate if they are retaining more people than predicted. Another note is that any surprising negative results could imply that there may be a problem with policies that have been adopted in that state. These findings will continue driving this policy analysis, as the thesis dives deeper into how state policies impact logGDP per capita, the proportion of poverty, and emigration levels.

Chapter 6: States of Interest with Low Emigration, Low Poverty, Low GDP

The five states highlighted for their low logGDP, proportion of poverty, and emigration under the model excluding less indigenous states, vary in demographics, but agricultural factors could explain such a pattern. The states of Yucatán, Sinaloa, Michoacán, Aguascalientes, and Sonora vary in indigenous population from 12.8 to 65.4 percent, meaning other factors besides indigeneity could explain this pattern observed. In 2021, the top five states with the highest agricultural productivity are Jalisco, Veracruz, Oaxaca, Chihuahua and Sinaloa, producing a cumulative amount of 114 million tons of agricultural products (Gobierno 2021). Although Sinaloa is the only one that makes this top five, the other identified states are also large producers in agriculture and or livestock. Michoacán makes up about 14 percent of total agricultural value in the country in 2018, with only around 8,600 fish and agriculture workers; while Sonora, with a workforce of almost 29,000, makes up about 7 percent of agricultural value in the country in 2018 (Agroproductores 2018). In Yucatan, out of the over 100,000 people involved in the primary sector in 2020, about 60 percent worked in agriculture and almost 30 percent in livestock while the rest worked in fishing (SADER 2020b). For Aguascalientes, its small geographical size and large urban area limits its agricultural capacity, but it also profits from livestock (SADER 2020a). These five states have varying productivity and contributions in the primary sector, specifically agriculture; therefore, other factors or policies could be influencing this pattern.

SINALOA

Starting with Sinaloa, the state contributes over 12.5 million tons of agricultural products, with their top products being maize, sorghum, and jitomate, a type of tomato (Gobierno 2021). In 2020, the total value of this production neared 61 billion pesos, almost 10 percent of the total national level (CODESIN 2021). For the poverty rate, indigeneity, and emigration, 30.9 percent of the population is experiencing poverty, and only 2.7 percent are under extreme poverty, while the proportion of emigrants is 4.4 percent, and 12.8 percent of the population is indigenous. Recognizing the employment and economic importance of the agricultural sector, the Secretary of Agriculture and Livestock of Sinaloa prioritizes cost-effectiveness, sustainability practices, modernization of infrastructure and equipment, and access to national and international markets (Sinaloa 2022). A significant difference between Sinaloa and the rest of the country is that about two-thirds of the agricultural land-holders are large-scale farmers, with the rest being mostly medium scale and few small-scale. The opposite is observed in the country as a whole with the majority being smallholders (World 2014). This dynamic impacts agricultural production, employment, and environmental systems.

The evolution of agricultural production in Sinaloa has allowed for booming export markets and innovation in sustainability. The main high-value crops are tomatoes, peppers, mangos, and cucumbers, making agriculture total 11 percent of the state GDP. One initiative the state government is implementing is climate-smart agriculture, which promotes water saving, climate adaptation, and other productivity actions. Investing in

such practices will improve irrigation infrastructure, greenhouses, crop diversity, and precise pesticide or fertilizer application. Many of these are already updated practices, as Sinaloa utilizes greenhouses or protective measures for their high value crops, and an average of 61.7 kilograms per hectare of pesticides, only half compared to other Latin American countries and OECD countries (World 2014). Some of the effects of climate change that the state is already experiencing are more severe droughts, frosts, and temperature changes, which have all happened in the span of the last decade (World 2014). The Sinaloan government recognizes the need for long-term management planning of the agricultural sector, in order to maintain high productivity and profitability.

The idea of shared prosperity is in dispute in Sinaloa, as the large landholders obtain most of the profit, while farmworkers often migrate within the state during various seasons or have unstable employment. The busy time of the year is harvesting in autumn and winter, which leaves agricultural workers under-unemployed between June and September, unless they seek employment elsewhere. Some of the challenges observed in Sinaloa are similar to other states where there is little government support or provision for financial and technical assistance. In addition to the increased commercialization and globalization of agriculture, price fluctuations cause varying profits from year to year (World 2014). Both the private and public sectors of the state need to combine forces to provide landholders and workers with safeguards against climate and unemployment through climate-smart agriculture and government interventions.

Climate change also has impacted crop production; therefore, other state-wide programs need to be considered such as disaster preparedness; infrastructure improvements; protected agriculture such as greenhouses, shadehouses, and tarp crop coverings; and climate-adaptive strategies. One way that productivity has advanced is through non-governmental farms associations to mobilize farmers, such as the Confederation of Agricultural Associations of the State of Sinaloa (CAADES) (World 2014). Climate warning systems and improved irrigation technologies could provide insurance buffers for farms during drought years. Also, water companies can lead drought preparedness, as in the case of the Taxtes Irrigation Module and Aupa Montelargo, who provide irrigation aid. Current state programs that encourage sustainable agriculture provide subsidies and technical assistance through the Secretariat for Agriculture, Livestock and Fisheries (SAGYP) and the Council for the Development of Sinaloa (CODESIN). However, federal entities still remain the largest contributors to such practices in Sinaloa (World 2014). These supportive policies and entities will remain important when considering recommendations to promote climate adaptive practices later in this thesis.

MICHOACÁN

The state of Michoacán is one of the largest agricultural producers in Mexico, contributing to 13.3 percent of the national value. Michoacán produces 120 million tons with agriculture covering 1.1 billion hectares of land, and agricultural products valuing up to 80 billion pesos (Agroproductores 2018). Some of their most profitable crops are

maize, avocado, strawberry, blackberry, hay, sorghum and lime (Agroproductores 2020). Four crops make up 70 percent of total land planted: maize, avocado, sorghum, and grass (Orozco-Ramírez et al. 2017). The state provides 4.4 percent of the total national value in agriculture, and around 1.5 percent for fishing (Agroproductores 2020). The state has a poverty rate of 46 percent and 6 percent extreme poverty rate, with an indigenous population of about 27.7 percent and emigrant population of 4.4 percent (INEGI 2020a & b). Michoacán has high agro-biodiversity with some traditional indigenous agriculture, but large landholders are on the rise as most of the profits are reaped in larger farms. NAFTA also influenced this expansion since the mid 1990s, as Michoacán's global market opportunities opened up. The state also experienced large migrations at this time as people moved to the United States, changing rural communities. This also caused a reduction in local consumption of beans and maize, in turn reducing their cultivation, with beans being replaced by meat or other protein sources (Orozco-Ramírez et al. 2017).

Avocados alone contribute 40.4 percent of the total agricultural production value in the state at 34.4 billion pesos, making it the most valuable product warranting the name of "green gold" (Agroproductores 2020; Lanza 2021). During the 1970s, Hass avocados were first tested on Michoacán land in the Uruapan and Meseta Purépecha region, composed of 11 municipalities (Curry 2021). As the powerhouse of the Michoacán economy, almost 1.7 million tons of avocados are produced every year, about three-fourths of the total national production (Agroproductores 2020; Mondragon and Lopez-Portillo 2020). Michoacán is currently the only state with the regulations in place

to export Hass avocados to the United States, with Jalisco underway of being approved, and they are able to produce them year around (Martin 2020). This regular production requires heavy pesticide use and often results in loss of biodiversity and health implications in the local community. When avocados' rising popularity and profitability first began, it pushed out the illegal plantations of marijuana and poppy (Curry 2021). The economic impact of avocados is experienced both in the United States and Mexico, as 82 percent of U.S. avocado sales are from Mexico, creating an output of $6.5 billion dollars, while thousands of employment opportunities have been created in Mexico. Michoacán farmers have benefited from government subsidies and cash transfers, due to this economic growth, which also allows for more competitive wages and lowers the probability of migration (Lanza 2021). However, the economic benefits have been heterogenous, in that certain communities remain in high poverty. Violence rates from criminal groups, such as drug traffickers and cartels, has also increased as they terrorize locals and landowners for resources and land (Linthicum 2019). Therefore, poverty alleviation is minimal across the state, especially in rural and indigenous populations, while large-scale farmers concentrate most of the power and wealth in the avocado industry (Curry 2021). Despite the lucrative export economy avocados have brought unexpected; consequences both social and environmental threats have created an unsustainable market and domestic issues.

In the face of climate change, Michoacán's economic and agricultural vulnerabilities are in danger, as forested zones and valleys of varying climates are

overwhelmed with agricultural production (Orozco-Ramírez et al. 2017). Since two large mountain ranges, the Neovolcanic Belt and the South Sierras cross through Michoacán, there is a focus on developing in the central west Valley where avocado and lime production has skyrocketed. Avocados need a humid and temperate climate, and Michoacán has rich volcanic, andosol soil perfect for production (Linthicum 2019; Curry 2021). However, with deforestation, between 30 and 40 percent solely in Michoacán (Mondragon and Lopez-Portillo 2020), to make space for avocado orchards, could have a negative impact on this ideal climate in the future. Aquifers are declining, as almost 70 percent of the water supply is directed to agriculture. The lack of crop diversification could also lead to soil depletion, increased crop-disease risk, and negative effects on the local ecosystem due to the heavy use of agrochemicals and forest fragmentation. The Michoacán government has done little to mitigate or regulate the negative effects of such land-use changes (Vega-Rivera and Merino-Perez 2021). Without prompt intervention to slow down or improve the avocado industry, the environment and local communities will continue suffering the brunt of the consequences.

SONORA

Sonora is the only state from this list that borders the United States, with implications for agricultural export, productivity, and technology. In 2016, around 760,000 hectares of land were devoted to agriculture, with about 694,000 hectares having irrigation (SAGARHPA 2016). The six million tons of agricultural production brought in 40 billion pesos in 2017 (Agroproductores 2018). Their top value crops are wheat,

asparagus, potatoes, watermelon, garbanzo, and other fruits and vegetables, which are often destined to the United States. Sonora is the 5th largest producer in the world of asparagus and the second largest for pecans (SAGARHPA 2016). The cultivation of these crops massively increased once Sonora improved its sanitation status to meet the requirements for global exportation. Through 14 municipal programs to boost agricultural sanitation, and developed technology for commercialization, agriculture has become 56 percent of Sonora's GDP in the primary sector. This rise in modernization is also due to NAFTA, as Sonora has benefited from globalization and the free market (Hernandez-Perez 2019). However, this economic opportunity came at the cost of exploitation of human labor and natural resources.

Despite having large deserts, with the help of aquifers, groundwater, and river dams, irrigation was made possible for Sonora. Both irrigated and rainfed land results in around 5.5 million tons of annual production. However, unsustainable irrigation techniques like overflooding land through gravity or pumping can waste up to four billion gallons of water a year. This irrigation technique is often used in southern Sonora and some parts of the Sierra region (SAGARHPA 2016). In the face of intensifying droughts, this poor efficiency in the use of water could cost the state more than basic improvements in hydraulic infrastructure. These consequences were already observed in 2021, as southern Sonora had to stop irrigating about 100,000 hectares of land due to prolonged droughts, and is currently uncultivated. One way to mitigate these effects is using organic materials to help retain soil moisture (Sequia 2021). Typically the state experiences the

rainy season in late summer or early fall in preparation for cultivation, but this drought will cost one million tons of product. Aquifers are also of serious concern, as the replacement time for groundwater is much slower than dammed water. Saltwater intrusion in areas near the coast of the state contaminates groundwater and makes it unsuitable for drinking and agriculture.

Due to Sonora's success with the passing of NAFTA, it is considered a reference to a successful, competitive agriculture industry. Undergoing several technological innovations and modernization since the 1980s, the Sonoran government is recognizing the need for an agricultural system that revolves around state priorities rather than solely catering to transnational, private interests (Hernandez-Perez 2019; Flores 2020). The state must go further to restore previous practices that emphasize state consumption rather than market demand (Sierra 2007). Forms of such policies would promote organic, sustainable agriculture; access to technological assistance or agronomists; a more democratic financial system for rural areas; and reorientation to more staple crops (Hernandez-Perez 2019). Although commercialized agriculture has aided Sonora in becoming an export-intensive state, combining this system with more sustainable or traditional options could help refocus agriculture production to state consumption.

YUCATÁN

With its combined production in agriculture, livestock, and fishing, Yucatán is part of the described group pattern because of its successes in these areas and possibly other factors. Yucatán has the highest indigenous population from these five states at 65.4

percent indigenous, with 40.8 percent of the population experiencing poverty, and 6.7 percent emigrants. However, similar to the state of Aguascalientes and Jalisco, Yucatán has a low rural population of 14 percent (INEGI 2020). Three municipalities in Yucatán focus on agricultural production with the top crops being pastos (hay), grain maize, and oranges. For livestock there is a focus on pig, chicken, and beef, while for fishing it is octopus, grouper fish/sea bass, and lobster (SADER 2020b). In 2017, Yucatán experienced a drop in production due to several factors, but especially climatic consequences, such as drought that hit major cultivation areas. These drought periods are expanding to up to seven months out of the year, yet the production value still increased to almost 4 billion pesos that year, up 7.6 percent from 2016 (Yucatán 2019). Meanwhile, the 2020 total international exports of fruits and vegetables were valued at over $20 million, with the United States being the top buyer (Yucatán 2022). In 2019, the Yucatán Secretary of Rural Development (SEDER) had increased their budget for agriculture to 500 million pesos, which reached an additional 9,000 small-scale farmers. This investment has allowed for improved technologies to boost production to up to 5.5 billion tons a year, composing 2.1 percent of the national agricultural production (Chan 2020). Yucatán's economic growth in agriculture and other primary sectors has created a promising future for production.

A notable difference from other state agricultural land is that about a third of Yucatán's land utilizes milpa, a traditional Mayan growing technique. Maize, sweet potato, pumpkin, and various legumes as cover crops are grown under the system of

milpa. This system is utilized in subtropical and tropical areas, and around 800,000 hectares in Yucatán are under this cultivation technique, producing over half of the maize for the state. The traditional "communal use" culture within the indigenous communities of Yucatán has allowed for diversification of techniques and crops, but less participation in global or external markets (Garcia et al. 2021), which differs from the other states included in this thesis. Communal use allows for more political inclusion and community-driven norms, while still maintaining tradition within the indigenous group, as outsiders often are not allowed to work the lands. Following a system similar to slash-and-burn agriculture, the migratory nature of the system is meant to take advantage of all the natural resources in the tropical areas. Potentially problematic changes for the milpa system are shortened fallow periods and less agrodiversity, which has reduced the fertility of the lands. Other versions of milpa exist that are more modern or ecologically-friendly, such that they require minimum tillage or plowing. Deforestation and deliberate burns are also dropping in areas such as Xohuayan that have diverse, sustainable systems, although this does not apply to most areas in the state. Finally, the younger generations often migrate outside of Yucatán to other Mexican states or the United States to pursue employment, which could reduce the amount of small-scale cultivated land because of the labor shortages (Garcia et al. 2021). With the increasing drought periods and changing demographics, the traditional milpa systems could benefit from climate adaptive strategies that will still allow for greater productivity.

AGUASCALIENTES

In Aguascalientes, almost 81 percent of the population lives in the city, while only 4.5 percent work the primary sector with agriculture production in two municipalities. The state's poverty rate is 26.2 percent, with 1.2 percent of the population in extreme poverty in 2018, which goes hand in hand with the small indigenous population making up only 11.7 percent in 2015 (INEGI 2020a). Although Aguascalientes used to be ruled by three main indigenous groups, many of these people were either killed or displaced by war and epidemics in the rise in Spanish colonial power (Schmal 2015). About 35.7 percent of the land is irrigated, while around 64 percent is only periodically cultivated, with their most cultivated crops being maize, beans, tomatoes, and guayaba. In 2020, the primary sector brought in 8.6 billion pesos, but most of this comes from livestock (SADER 2020a). Since Aguascalientes has the least agricultural potential among those discussed in this thesis, much of its wealth comes from other industries such as textiles, electronics, and automobile parts, and its centralized location allows for easy access and transportation to major cities such as Mexico City (Schmal 2015).

Similar to other parts of Mexico, Aguascalientes struggles with inefficient water usage, overexploited lands, and polluted waterways, due to underinvestment in agriculture and rural development. The inadequate climate, with unstable rainfall, limits the potential for annual cultivation, which is why most of the agricultural land is only periodically used; instead cattle and other livestock industries are more prevalent (CODEGEA 2010). The typical growing season occurs from May to September, when

precipitation is highest (Ruiz-Alvarez et al. 2020). The maize and alfalfa currently grown is partly used to feed this livestock. Furthermore, eroded soils and lack of proper irrigation systems have made agriculture a non-competitive industry with little prospect. This impacts those currently in agriculture; as this could promote migration from rural and agricultural areas. Agriculture production could be improved through active soil restoration, drought-tolerant crops, and short-cycle crops (CODEGEA 2010; SADER 2019; Ruiz-Alvarez et al. 2020). Since the extraction of water and resources is much higher than natural recharge rates, Aguascalientes will have to implement holistic policies that consider infrastructure investments and climate-adaptable, region-specific strategies.

PART III: Conditioning Factors and Past Policies

Chapter 7: Policy Support for Large-Scale versus Small-Scale Livelihoods

To identify policies Mexico could benefit from implementing, it is necessary to discuss the conditioning factors of why small-scale and indigenous farmers are migrating. Indigenous people are leaving their land because of poverty, limited wage opportunities, lack of infrastructure, and weak policy protections. The previous discussion of specific Mexican states highlights how these issues vary by region, but that it is possible to mitigate migration, raise GDP per capita, and lower poverty rates. Although low migration and poverty rates are signs of success, these states' low GDP per capita is contradictory to this pattern and needs further analysis. Agriculture and other primary industries are crucial for thousands of jobs in the state and national market. However, the ways in which each state is contributing to pro-campesino, traditional and sustainable agriculture is still unknown. What those policies are will be further discussed in this chapter.

Omnipresent support for large producers from government entities has created an economic strategy to financially aid large landholders with not much going to small landholders, which has made it more difficult to compete in the market. To compensate for this, the national government has provided social welfare funds for the rural poor instead. Agrarian reform was first prioritized by the Mexican government in the 1930s, when pro-peasant policies restored ejidatario systems and redistributed commercial

farmlands to rural populations. Yet, the short-lived policies rebounded by the 1940s when substantial investment was made in northern Mexico and irrigation systems to large landholdings. A reinstated interest in pro-peasant policies came about in the 1970s, but had little success at reaching their target population. The large decline in agricultural employment is partly due to NAFTA, where consequences in migration and poverty were observed in rural areas as thousands of people were left jobless (Fox 2010). Low-quality education, inaccessible healthcare, and social welfare programs perpetuate this cycle of migration, in that economic opportunities are pursued outside of rural and agricultural communities. The unequal distribution of subsidies, infrastructure investment, cash transfers, and support prices from the federal government across states during urbanization has created a stark difference between large-and small-scale farms.

NATIONAL POLICIES FOR RURAL SOCIAL WELFARE AND ECONOMY

An example of a social welfare program directed at the rural poor starting in the 1990s include conditional cash transfers through the Progresa program, which has had mixed results in poverty alleviation. The program is meant to provide short term poverty relief through direct payments to the poorest initiated because of the petroleum crisis in the 1980s and an economic crisis in the mid 1990s (Licona et al. 2019). Therefore, this cash transfer program becomes the main social welfare opportunities that require specific behaviors from the beneficiaries. A previous era of pro-peasant economy was last experienced in the 1930s, when agrarian reform redistributed lands to campesinos. In 1991, another sweeping reform strengthened the land-use rights and individual titling to ejido communities, which make up half of Mexico's agricultural land (FAO 2016). This

opened up the possibilities to produce and participate in agricultural programs. Originally introduced as the Progresa-Oportunidades-Prospera (POP) program, Progesa became a means to increase the rural poor's income by around 30 percent to increase education and healthcare among women and children (Fox 2010; Licona et al. 2019). The conditions require health-care visits and nutritional education for children and pregnant women, which included monthly transfers of 90 pesos (equivalent to 232.38 pesos in 2022) directly to women in the first years of the program (Gertler and Boyce 2001). The Mexican government claimed success, such as improved nutrition and health along with reduced extreme poverty. Yet, breaking the generational cycle of poverty still has not been achieved (Licona et al. 2019). Program deficiencies in education quality and inconsistencies in coverage, despite serving over ten percent of Mexican families, has made the program insufficiently effective.

A progressive, pro-peasant federal policy was established in 1993 called Procampo, Programa de Apoyos Directos al Campo, through a newly created agency of Marketing Support and Services Agency (ASERCA). The expected consequences from NAFTA such as decreased competitiveness and market power of domestic producers due to the high subsidies from partner countries, drove the Mexican government to enforce Procampo for a planned 15 years to mitigate these potentially harmful effects. With a fixed per hectare per harvest payment system, Procampo was meant to replace other federal programs like guaranteed prices for producers. Procampo also differed from other programs as its target population was rural farmers with five hectares or less, some of the poorest in the country, who also harvest for self-consumption (Fox 2010).

Although more redistributive in its approach and reaching over 2.6 million people by 2013, Procampo's flaws exacerbated inequality between smallholders and large holders, due to unimplemented caps on the size of landholdings that could qualify for the payments. Because of the regressivity of agricultural subsidies, the program also fails to address the root cause of economic opportunity (SAGARPA 2009). As emphasized earlier, the majority of Mexican farms are small-scale, subsistent, and located in rural areas, with indigenous smallholder farms accounting for a quarter of Mexico's farms. From 1993 to 2006, payments ranged US$100 or less per hectare, with some alterations made for additional funding in rain-fed land, indigenous municipalities, and smaller farms[1]. Payment ceilings were set at 100,000 pesos, but this was not always followed. Yet, over half of the subsidies were given to large-scale farms. The lack of urgency and initiative to change these faulty policy standards were partially the result of political influence from large landowners and ruling national parties. As of the last report of Procampo in 2012, 14.65 billion pesos were spent, with an expected 2013 level of 14 billion pesos. However, government reports do not have data beyond 2013 (SAGARPA 2013).

Even though the Mexican government claims Procampo had received international support because it does not distort the market by focusing on production and price rather than land, organizations like the World Bank have expressed concern for Procampo's questionable fine print. For example, the Ingreso Objetivo program established a minimum national price in 2003 to balance fluctuating international price

[1] In 2006, 60 percent of land eligible for Procampo were farms under five hectares (SAGARPA 2013).

markets (FAO 2016). However, four northern states[2] reaped over 70 percent of the program benefits until 2009. Furthermore, irrigated farmland, which typically exists in wealthy or larger farms, received Procampo payment twice a year (Fox 2010). Although Procampo has made small incremental improvements in reducing out-migration and increasing income, it could be redesigned to allocate more of their budget on their target population rather than also serving large landholders (SAGARPA 2009). In addition, environmental concerns could arise with Procampo since it prompts farmers to always cultivate their lands that traditionally were left fallow. An equity approach, instead of an equal opportunity approach, is necessary for future pro-peasantry policy.

When compared to Progresa, Procampo may have a greater potential for improving food security, by promoting both production and consumption. The assessment of the multi-layered reasons as to why one program could have more success than the other is because of the gender differences in the direct recipient and the investment capacity of the cash transfer. Women could invest directly to their families through Progresa, while male farmers could, who receive about 90 percent of the Procampo transfers, invest in the land through the program (Fox 2010). However, since eligible households can benefit from both programs simultaneously, both have the prospect of alleviating poverty and improving food security (Ruiz-Arranz 2006). Procampo may take longer to provide results, while Progresa provided immediate income and health changes. Progresa ended in 2019 due to significant challenges, especially ineffective implementation of a target population through corrupted systems that cost Mexico

[2] Sinaloa, Sonora, Tamaulipas, Chihuahua (Fox 2010).

millions of pesos that were not able to reach the poorest rural communities (Licona et al. 2019).

Meanwhile, Procampo is under a new name, the Producción para el Bienestar (PpB) program, which serves a similar purpose to support poor, rural farmers with a starting budget of nine billion pesos in 2019. Reform policies for PpB in 2022 include additional payments for coffee, cacao, honey, and sugarcane producers; 30 percent of the beneficiaries must be women; and 53 percent of the beneficiaries must be indigenous (SADER 2022). Depending on the type of grain grown on the farm, producers with two to five hectares can now receive between 6,000 pesos or 10,000 pesos annually, while 5-20 hectare grain farms will receive 1,200 pesos per hectare per year. Chia and amaranth farms can receive 3,000 pesos per hectare or up to 24,000 pesos annually. While for honey, coffee, and cacao producers, the payments are slightly higher, but they cannot exceed 24,000 pesos per year (SADER 2022). These policy changes offer promising improvements to expanding financial transfers to small-scale farmers. Under the current Lopez Obrador administration, other federal programs expanding infrastructure and agricultural capacity in 2022 include the Guaranteed Prices for Peasant Producers, Rural Roads, Fertilizers for Wellbeing (under Alianza), and Planting Life (Gobierno 2022).

The Strategic Food Security Project (PESA) created in 1994 and designed by the FAO is an example of international organizations aiding Mexico's agricultural policy and rural development since 2002. Funded by SAGARPA, the project focused on highly marginalized communities by providing technical assistance and tools developed by the FAO, especially after the FAO recognized how Mexican governmental programs were

failing to reach the rural poor. The methodology included local stakeholders and families to decide on a strategy of food security and an economic development action plan. This community participation allows for region-specific planning and challenges, which allows for community evaluation of such projects and recommend changes. In 2013, PESA was aligned with the National Crusade Against Hunger (CNCH), where malnutrition and hunger coalesced with low-agricultural productivity levels (Zapata et al. 2016; AMBIO 2018). The diversity of projects can include anything from the promotion of hygiene, conservation, and food preparation to income opportunities such as ecotourism, organic production, raising livestock, or water catchment systems (CONEVAL 2014). Oaxacan and Chiapan local organizations or companies have also collaborated with PESA and FAO initiatives, such as the Cooperativa AMBIO, which focuses on the sustainable management of natural resources (AMBIO 2018). Even though PESA has expanded its access to municipalities, and funding increased from 600 million pesos in 2007 to 3.3 billion pesos in 2015, the breadth of PESA fosters a lack of self-evaluation and success analysis on an institutional level, which causes bureaucratic problems in local assistance and resources. This is due to the fact that Agencies of Rural Development (ARDs), professionals monitoring and providing the support must be created for PESA to be established in a locality (Bennett et al. 2013). Therefore, PESA, like the previously-mentioned federal programs, has space for improvement.

STATE POLICIES FOR RURAL SOCIAL WELFARE AND ECONOMY

In addition to federal programs, decentralized programs run by all Mexican states, such as the Alianza para el Campo (ApC), has operated since 1996 and has offered

investment subsidies to small-scale farmers. Alianza differs from Procampo in that subsidies are given to project-based applications describing the purpose of the investment. This can vary over farm equipment, infrastructure, supplies, and professional consultations. Subprograms of Alianza are Rural Development subprogram and the Agricultural Support subprogram, targeted to poor rural communities; however, according to the FAO, many of these programs lack consistent objectives and data. Overly complicated, onerous applications, and the high upfront costs of investment, create barriers for low-income producers, whom this program is supposed to support. The bureaucratic nature of the program favored larger producers, who could more easily apply. They are also in more productive, wealthier states with irrigated lands; these producers also have more political influence and investment capacity. Between 2002 and 2009, the states of Oaxaca, Chiapas, and Veracruz, comparatively poor states, received high total allocations from Alianza, yet so did the rich states of Jalisco and Sonora. Due to an inconsistent formula determining federal fund distribution to states, long-term planning and implementation for states was very challenging. Subprograms under Alianza specific to rural communities are Development of Rural Means Capacity (PRODESCA), Strengthening Rural Organizations (PROFEMO), and Support for Rural Investment Projects (PAPIR), which have had mixed effects (Palmer-Rubin 2010; Fortalecimiento 2016). Despite these progressive, decentralized efforts, Mexican states still struggle providing access to these resources for their target rural population due to the aforementioned barriers.

SINALOA

In the state of Sinaloa, the main agricultural policy issues to address are financial support, especially for small-scale farmers, which impacts employment, migration, adaptation to climate change, and public services. Sinaloa has a booming agribusiness, with large landholders having strong technologic and financial resources for investments, with the potential for greater sustainability initiatives and development of pro-small-scale farming policies. In 2017, a program to support small producers was introduced, the "Componente de Extensionismo, Desarrollo de Capacidades y Asociatividad Productiva (CEDCAP)" (SAGARPA 2018). This program extended aid to rural producers to help in the transition to more appropriate technology, especially those with in-access to the market, relying solely on subsistence farming. To facilitate the implementation of climate-smart technology, various techniques such as drip irrigation, cover crops, and precision agro-chemical application are used in some farms, but could be more widespread through productivity assistance and subsidies. The Secretary for Agriculture, Livestock and Fisheries of Sinaloa (SAGYP) works with the federal government to provide this assistance, such as the Trust Fund for Rural Development (FIRA), which provides energy efficiency grants. Economic development agencies such as CODESIN, have consulted the government with hydro-electric projects for agricultural production, but most of these initiatives center on private sector actors and foreign investment (World 2014)

MICHOACÁN

Some agricultural issues in need of policy action in Michoacán are the lack of crop and economic diversification, unequal distribution of wealth, and the underdevelopment of agribusiness (Ortiz-Paniagua 2017; Delfin-Ortega and Valencia 2015). These issues build upon each other in which wealth generated through international exports is not being distributed to municipalities in need. The agribusiness sector requires better implementation of technological or innovation programs to improve its production systems (Delfin-Ortega and Valencia 2015). Recent efforts to promote rural development occurred through the Secretary of Rural Development and Agri-food Program (PDS-SEDRUA) 2015-2021 to transform the state's self-sufficiency and competitiveness (Maurin et al. 2016). Increasing local, national, and international market opportunities, aggregating product value, as well as technological adoption policies, are outlined in various subprograms. A future focus under consideration for Michoacán is the generation of agricultural value during 2022 to 2024, which could improve the market for other fruits to the value level of avocados (Michoacán 2022). An environmentally friendly initiative called Agrosano is a follow up to the Sustainable Agriculture program, where 132 million pesos will be dedicated to producing organic fertilizers, criole seeds, bio-supplies, and biodigesters to reduce the use of agrochemicals within the next few years (Rios 2022). Although these initiatives have promise, it is not clear whether the rural poor will greatly benefit from these programs (Torres 2022).

SONORA

Sonora is one of the most capital-intensive, productive, and irrigated states in Mexico, which makes it one of the wealthiest in agriculture (Palmer-Rubin 2010). Sonora's relative success comes from electric-dams and extensive irrigation systems that provide over 6.8 billion cubic meters of water annually (SAGARHPA 2016). However, its greatest strength is also its greatest weakness, as rainfall has dramatically decreased and forced thousands of acres to go uncultivated due to the long-lasting drought and outdated irrigation systems (Romo 2021). The System of Agricultural Innovation (SIA) is an international concept that promotes the advancement of economic and social services that successfully apply technology in agriculture. In Sonora, SIA played out by integrating hybrid seeds, machinery, drip irrigation, private transnational corporations, and diverse export crops produced mainly by large-scale farms. Agro-exports have skyrocketed Sonora's commercial crop value, leading to a growth in GDP over time; however, this poses significant barriers to any producers wanting to enter the market (Sierra 2007). The fast-paced infrastructure changes transformed certain areas like the Valle del Yaqui and Valle de Mayo that traditionally produced crops, which switched to mechanized farming for wheat and cotton (Flores 2020; PIEAES 2021).

The rural poor's role in this growth has largely been through labor on large-scale farms, but they have not reaped the economic benefits nearly as much. Small-scale producers lack financial resources, and the Sonoran government is troubled by the influx of rural migrants into urban areas. Therefore, the Sonoran government is considering ecosystem service payments, where rural areas conserving natural resources could get

paid for their efforts (SAGARHPA 2016). However, more action is needed to produce rural jobs or access to the agricultural market in Sonora. Currently, the Sonoran government is agreeing to provide accessible credit for specific small-scale producer projects by eliminating the paperwork that typically creates technical barriers and time lags (FND 2022). With Sonora's overexploited lands and changing rain patterns, the state government is forced to consider how the large-scale grain farms could aid in the future food crisis through sustainable agriculture (PIEAES 2021).

YUCATÁN

As mentioned earlier, the state of Yucatán dedicates one third of its agricultural lands to the milpa system, which is threatened by overexploitation of land, large-scale agriculture, worsening weather, and migration from agricultural lands (Garcia et al. 2021). Over exploitation comes in a variety of forms, from reduction in fallow periods to increased industrialization of the bovine and pig industries (Garcia et al. 2021; Connor et al. 2021). Climate change has brought about harmful rainfall that wipes out fields; in response, rural communities have attempted to incorporate more climate-smart agriculture or an improved milpa system, which would minimize deforestation and implement fertilizers and irrigation (Popkin 2017). International support from the Nature Conservancy (TNC) has fostered the Yucatán Peninsula jurisdictional program for "forest conservation, sustainable rural development, and reducing emission from deforestation and forest degradation (REDD+)", which includes the states of Yucatán, Quintana Roo, and Campeche (Varns et al. 2018)**.** The Direct Support to Rural Development (PADDER) is a state program directed to agricultural communities for economic aid, but there is

currently no emphasis on poor or indigenous producers. Subsistence producers in Yucatán consume 25-75 percent of their milpa crop, with agriculture bringing in 30-50 percent of a family's income. Most commercialized crops go directly to local consumption (Dorantes 2021). The state government is prioritizing productivity growth and has invested 1.285 billion pesos from 2018-2021, and observed 30 percent growth in product value since 2018 (Quadratin 2022). Another project underway is the Tren Maya, which will connect tourist zones to boost the economy in five southern Mexican states, 1,525 kilometers of track running through Yucatán, Chiapas, Tabasco, Campeche, and Quintana Roo (Turismo 2022). These states contain high concentrations of indigenous populations, and the train will ideally serve agricultural producers in these communities. The local producers of Yucatan, who practice community-driven agriculture ["unidades familiares agricolas (UFA)"], are determined to maintain their livelihoods and reduce migration to economic opportunities in tourist areas. State programs that promote diverse croplands that protect forests, increased local market and employment opportunities[3], and government investment or subsidies would allow for year-round income for rural growers (Dorantes 2021).

CHIAPAS

As one of Mexico's top producing agricultural states with an agricultural workforce size equivalent to Veracruz and Michoacán, Chiapas' indigenous communities have had a significant impact on promoting sustainable agriculture in the state since the 1990s (DataMexico 2021). The creation of alternative markets and networks has allowed

[3] Agroforestry, fruit tree production, and livestock are potential market avenues (Dorantes 2021).

Chiapas to maintain communal knowledge and land-use, while adapting to globalization and agro-export industries. As Mexico is one of the top ten coffee producers, Chiapas is Mexico's largest producer (Garcia and Santiago 2006). The coffee market offers price premia for organic coffee and other crops that would otherwise go for a fraction of the price domestically (Nigh 1997; Martinez-Torres 2008). This sparks a food security issue in which organic coffee is predominately exported and takes over lands that could be used for domestic product cultivation (Garcia and Santiago 2006). Since Chiapas did not benefit from past rural infrastructure investments such as irrigation and roadways, small-scale producers are at a severe disadvantage for starting up an organic farm. Barriers still exist when small-scale producers want to gain access to the organic market, as social capital and professional and organizational networks are necessary to obtain organic certification and commercialization (Martinez-Torres 2008). Organizations supporting the growth of organic production since the 1990s are ISMAM, Arte Natura, Red de Maíces Criollos de los Altos de Chiapas, and the Union de Productores Maya Vinic, which provide network opportunities and aid for the organic farm transitions (Nigh 1997; Garcia and Santiago 2006; FAO 2022).

Organic farming can be an intermediate employment opportunity since poor, rural producers do not need expensive technology or large plots of land, but the increased labor intensity of organic farming could incur more expense. Depending on the situation, family or community labor could be used to compensate for this. Chiapas' mixed forest and jungle environment are ideal for traditional coffee cultivation that requires layers of trophic vegetation that provide shade for the coffee plant and ground cover

(Martinez-Torres 2008). Although productivity levels vary based on altitude, soil quality, and weather, producers can see similar productivity results using chemical or organic inputs, which does not include long-term benefits gained such as soil health. Ecological impacts, in conjunction with technology or mechanized agriculture, degrades soil quality where erosion and cover growth or decomposed organic matter are severely impacted. In anticipation of climate change, indigenous and rural, poor farmers have adopted several strategies to safeguard against warming temperatures, decreased rainfall, changing growing seasons and northern winds, and vegetation loss in mountainous areas (Sanchez-Cortes and Chavero 2011).

PART IV: Projections of Recent and Future Policy Goals

Chapter 8: Migration and Poverty Alleviation

The previous chapter introduced ways the federal and state governments of Mexico have navigated the issues tied to climate migration, rural development, and rural employment opportunities. Projections of future programs may spark some optimistic outlooks for the Mexican agricultural economy. Many of the aforementioned initiatives and programs have had mixed success and some were even terminated as their target audience (indigenous, rural poor, small-scale producers) was rarely reached. Although each of the state governments had its own strategy to combat climate migration or unemployment, a general trend is observed in which both sustainable and climate-smart agriculture in large-scale and small-scale farms is instated as a means to promote long-term solutions. Therefore, the synergy between small-and large-farms has the potential to construct a solid foundation for domestic and export consumption. The future of Mexico is dependent on whether federal, state, and local governments can collaborate on programs and resources to mitigate the problems of food security and migration. Wide-spread adoption of sustainable agriculture could prevent further environmental destruction and restoration of both agricultural and wild lands (PIEAES 2021). In regard to uplifting rural communities, the inaccessibility to participate in the market; to obtain loans, subsidies, and credits; and to support infrastructure improvements are the driving forces behind economic migration. Climate migration is induced by worsening droughts,

warming temperatures, unpredictable rainfall, deforestation, deteriorating soil quality, and extreme tropical cyclones. These conditions exacerbate poverty and inadequate social programs have failed at addressing the root causes.

Within the past decade, international agreements that address climate migration or rural out-migration include Mexico's commitment to the 17 Sustainable Development Goals (SDGs), the United Nations Development Program, the Global Compact for Safe, Orderly, and Regular Migration, and the Paris Agreement (CEPAL 2021). However, current projections for Mexico do not demonstrate sufficient alignment and action to reach these goals. The Covid-19 pandemic has reduced the likelihood of reaching several 2030 goals that could engage indigenous people, women, and afro communities in climate resilience initiatives as well as creating temporary job programs for migrant populations (United 2021). With aid from the Global Environmental Fund (GEF) and the German Cooperation fund (GIZ), biodiversity and agricultural projects are underway that center on ecosystem restoration and fragmentation, agrobiodiversity through traditional farming, and conservation (FAO 2022).

Greater emphasis should also be placed on in-place adaptation, facilitation of internal migration, and post-migration preparation that would safeguard against a cycle of poverty. In-place policies could range from expanding climate-smart or organic agriculture, programs that preserve traditional knowledge, marketing or technology training, or government subsidies or investments (Kumari et al. 2018; Parraguez-Vergara et al. 2018). Enabling internal mobility include programs like CADENA, where its humanitarian aid stretches from reconstruction from natural disasters and economic

revitalization through education and resilience-building (CADENA 2022). These actions are linked to post-migration where services and labor markets for migrants through skills training, legal support, and information provision can facilitate their transition (Kumari et al. 2018). These international agreements are a great starting point for international migrant protections, but more needs to be done for internal migrants.

One of the economic issues that needs to be further addressed is the inconsistent flow of income, since unpaid family labor and paid seasonal farm labor dominate most rural or agricultural employment. Post-NAFTA unpaid family labor decreased for a variety of reasons, while seasonal paid labor rose (Fox 2010). Income/livelihood diversification through migration into urban areas or other local markets covers the typical choices rural workers make to get by throughout the year. A single family member leaving to send remittances back home could remove the risks of the entire family migrating, while providing another income source (Milan et al. 2016; Escobar 2020). Some other alternative income opportunities include leasing/renting one's land or selling land to developers or agri-businesses, which could lead to loss of de facto and usufruct rights (Lara-Ponce et al. 2017; Vega-Rivera and Merino-Perez 2021). The standardization of minimum wage is also essential for procuring the breadbasket necessities. In 2019 and 2020, national efforts to increase the minimum wage by 22 percent has lifted millions of people to a livable wage, where agricultural producers are paid around 213.39 pesos (US$10.67) daily and agricultural workers given 172.87 pesos (US$8.66) a day (Secretaria 2021; Secretaria 2022). Although policy solutions will vary by region (e.i. Michoacán and Sinaloa have greater seasonal worker populations),

ensuring that all farmworkers and owners are guaranteed a living wage is crucial to community cohesion, livelihoods, and land-use sovereignty.

Poverty alleviation through social programs is possible if there is a focused population who can only receive these benefits and a system of checks and balances is established for bureaucratic processes. Since targeted investment to rural farmers though public policies and programs has not been enough to alleviate poverty and employment instability, private actions could aid in the process of mitigation. These Public-Private-Partnerships can enhance intersectional policies that require multiple perspectives and solutions (UNCTAD 2013). Some options could implement lendable funds with low-interest rates or alternatives to collateral, specifically for rural, poor producers (Palmer-Rubin 2010). Many small-scale farmers struggle with receiving sufficient funding; therefore, access can be expanded by removing such barriers.

GENDER IN EL CAMPO

Gender dynamics in the agriculture sector has weakened women's potential influence in decision making, especially indigenous women. When it comes to economic resources, Mexican women face greater inequalities, especially in agriculture that continues to be a male-dominated industry (UNDP 2020). Women are less likely to receive an income for their labor, in general; however, prospective trends show the number of unpaid women in the campo has fallen from 26 to 13 percent from 2010 to 2015. Other trends include less women working on their own land as well as women typically being in charge of shepherding and domestic work (Escobar 2020; Paraguez-Vergara 2018). Other traditional gender roles would include stocking seeds,

domesticating seeds, creating medical plant uses, producing artesanal products, managing water and wood, and preparing food (Instituto 2015). Over ten million poor, rural women, 60 percent living in poverty, are often tied to their communities: their lives dictated by local culture and markets. Despite these issues, Mexican rural women are responsible for over half of the national food production (Instituto 2019). Many rural women are also indigenous, facing greater forms of oppression with even less resources. Making up such a large portion of the population and economic power, poor, rural women deserve financial support for their livelihoods. The most progressive policy described earlier, Progresa, attempted to address the issues of healthcare and education access inequality, but did not entail efforts to increase the number of female landowners. Therefore, it is necessary to empower Mexican rural women to pursue better income opportunities, and politically support them through access to property rights in order for them to benefit from agricultural cash transfers and investment support programs (Instituto 2019).

Recent federal policy efforts by the National Institute for Women (INMUJERES) strive for gender equality and to reduce violence against women through migratory protections, climate justice, sexual health resources, and economic empowerment. Although the majority of the INMUJERES' work revolves around the femicides currently experienced in Mexico, the intersection between women and climate change is evolving. Involving women in sustainability and environmental decisions is essential for local conservation. The connection of gender to climate change and human rights was highlighted in the 2022 convention of the Commission on the Status of Women (CSW). INMUJERES pushed the importance of mitigating the risks that come from the

environmental damages and socioeconomic challenges of climate change at the convention. In 2014, the Mesa Interinstitucional: Rural, Indigenous, and Campesina Women (MMRIC) was formed by INMUJERES to expand the understanding and importance of women's empowerment. Now under the Agrarian Law, at least 40 percent of commissary and supervisory groups have to be women, so they, too, have a stake as landholders in climate-change and land-use issues (Instituto 2022). Additionally, the Program for Temporary Employment was created for rural women to utilize monetary aid for community or family projects, such as compost or mushroom production, artisanal product making, and beekeeping. Twelve Mexican states underwent projects directed at indigenous, rural women in 2018, including Michoacán, Chiapas, Sonora, and Yucatán (Mexico 2018). Institutional and local changes for women are promising, but still have a long way to go to achieve gender equality.

Chapter 9: Indigenous Adaptations and Policies

If the history and lineage of indigenous Mexico is to be preserved, the success and challenges of indigenous people cannot be forgotten. Non-discriminatory opportunities for self-employment and commercialization are necessary to uplift families out of poverty. Public service information and documents need to be available in indigenous languages, especially in the top indigenous-speaking states (Oaxaca, Yucatán, and Chiapas), which are vital for equitable opportunities. In regard to food sovereignty, many staple crops such as beans, maize, and rice have dropped in production and been replaced by agro-exports like fruits. Instead, these traditional foods are imported, which disregards the value of native crops and agriculture systems, and makes self-sufficiency for the rural poor more difficult (UNCTAD 2013). Indigenous municipalities struggle to receive federal funding for rural development, despite their culture and economics relying on small-scale labor (Fox 2010; Perez 2014).

In 2019, the National Institute for Indigenous Peoples (INPI) forged protections for the 68 recognized indigenous groups (Naciones 2019). After decades of exclusion, the INPI program is planned to last from 2018-2024, dedicating policies to indigenous and Afromexican well-being (INPI 2018). The program Economic Strengthening of Indigenous Peoples and Communities (PROECI), for example, supports economy-building projects in eco-tourism, conservation, and community impact (INPI 2020). Other federal programs supporting rural development include Dignified Indigenous Living for home improvement, Comprehensive Indigenous Development, and

the Indigenous Infrastructure program, which spent 2 billion pesos in 2019, but was not active in 2021 (Consejo 2021). Transnational indigenous political groups could help connect isolated groups to economic opportunities as well, such as the International Forum for Indigenous Women (FIMI), Support Fund for Indigenous Peoples (IPAF), The Christensen Fund (TCF), the Indigenous Partnership for Agrobiodiversity and Food Sovereignty (TIP), and the Indigenous Ways of Knowing and Learning Initiative (FMICA) by the Tamalpais Trust (Tierney 2016). Many Mexican institutions have taken the first step in recognizing the importance of indigenous people, but now they must follow through with their prospective plans.

Organic agriculture, agroforestry, and natural resource conservation, coupled with indigenous knowledge and practices, could mitigate the issues of migration and sustainability. Regional organizations like CEDICAM are already promoting native seeds, integrating livestock with agriculture, incorporating cover crops, trenches to reduce erosion, and reforestation through community workshops and information exchange (Hernandez and Santos 2006). One strategy to boost moisture retention and biodiversity is limiting deforestation, as trees retain moisture and attract species (Sanchez-Cortes 2011). Agroforestry has been a successful practice in Zapotec and Maya communities; it does not clear land, and allows wildlife and ecosystem services to coexist, similar to conservation agriculture (Penniman 2015; Lara-Ponce et al. 2017). Agroforestry systems can be shade-grown cocoa or coffee, milpas, silvopastoral, and subsistence gardens, which can also contribute to carbon storage (Comisión 2020). Outside influences from agribusiness, however, discourages such systems from being

adopted. Expanding organic smallholder certification through non-profit support, for example the Mexican Network of Tianguis and Organic Markets (REDAC), could promote political action and financial aid to access markets. REDAC's efforts have fostered an organic movement for local and regional producing smallholders (Rindermann and Cruz 2015). Communities that depend on natural resources in protected areas, could apply for subsidiary support through the Sustainable Development Conservation Program (PROCODES) 2020, that provides technical training and conservation project aid (PROCODES 2020). Optimistically, organic agriculture and agroforestry remain one of the highest adopted sustainable practices in Mexico (World 2015).

Protected and climate-smart agriculture (CSA) could be more commonly used in the future where climate change will impact the consistency of weather patterns and create uncertainty in crop yields. Protected agriculture is anything that involves structures or techniques that prevent crops from adverse environmental issues such as freezing temperatures and hail. Highly technified structures like greenhouses, hydroponics, fertigation to less technified techniques like mulch, plastic covers, and thermal blankets could all contribute to the protection of crops (Aurelio and Escobar 2016). However, these techniques are more accessible in wealthier states like Sonora, Sinaloa, Baja California, and Michoacán and not readily available to poorer areas because of the resource and labor costs of installations. Nonetheless, larger farms could benefit more from having more advanced technology, especially in the context of climate change to prevent product loss. For CSA, agribusiness and small-scale farms can implement

renewable energy, sustainable waste management, crop rotation, and biodigesters. Sinaloa and Chiapas have made promising progress toward CSA from energy-efficient technologies and silvopastoral systems. The utmost challenge of climate change for Mexico is water scarcity in Mexico. Therefore, possible CSA techniques are "water harvesting, well perforation, water reservoirs, contour ditches, accurate irrigation scheduling", along with drip irrigation (World 2015). Since these practices require extensive infrastructure changes, some starter practices are cover crops, minimum tillage, and biofertilizers. If such investments in protected agriculture and CSA are to be accomplished, further collaboration between public, private, and international entities is necessary.

Ecotourism has emerged as a means to protect indigenous lands or uncultivated forests without forgoing the economic loss or subsistence of agriculture. As one of the top five countries in biodiversity, Mexico is challenged by several problems threatening this species richness, such as land-use changes, wildfires, invasive species, climate change, and infrastructure expansion. Ecotourism allows for a diversified rural economy stimulating jobs to improve income and migration rates (Mondragon and Lopez-Portillo 2020). Contributing to an average of 8.5 percent[4] of GDP with upwards of 20 million tourists a year, tourism has the potential to be both beneficial and exploitative as an emerging industry. Ensuring that small businesses and indigenous groups are included in the market opportunities will dictate the income distributional effects of tourism.

[4] Tourism's contribution to GDP dropped to less than 7 percent during the Covid-19 pandemic (INEGI 2020c).

Transportation is a limiting factor to tourism expansion, but projects like the Tren Maya plan to mitigate this issue (OCDE 2017; Turismo 2022). The 2030 Sustainable Tourism Strategy, as part of the National Development Plan of 2019-2024, will serve as a tool to boost social welfare, bioculturalism, and environmental responsibility and strengthen the "Pueblos Magicos" program with 132 locations (Turismo 2021). Government investments to diversify or create tourism projects, especially for small-scale businesses and indigenous groups, should be of top priority.

Chapter 10: Food Security and Agricultural Policy

International efforts to boost agricultural production, specifically within the maize and wheat industries, are occurring through the cooperation between the International Maize and Wheat Improvement Center (CIMMYT), the 2010-2020 MasAgro Program, and SAGARPA (IICA 2016). MasAgro plans to improve wheat and maize production by modifying seeds to better withstand drought and low-quality land. White and yellow maize represent 14.5 percent of the agricultural GBP and most of it going towards human consumption. The potential for maize expansion exists mostly in the southern and central regions (SAGARPA 2017). Wheat is mainly planted in wealthier, large-scale agriculture states. CIMMYT germplasm banks and labs contain over 28,000 maize seed varieties and over 152,000 wheat varieties, which facilitates hybridization. The future of MasAgro is developing sustainable technologies and seed varieties to continue increasing yields, particularly in rainfed lands (IICA 2016). This type of international collaboration to prepare for food insecurity and rising domestic food prices could be more common in the future to address global climate change.

Traditional maize has undergone several changes over the years, including the possible extinction of Creole maize breeds (Lara-Ponce et al. 2017). Indigenous groups have formed to protect these seeds such as the Network in Altos of Chiapas for Creolle Maize, primarily led by indigenous women (FAO 2022). Since the capacity for small-scale agriculture does not align with mass production initiatives, other systems such as milpa intercalated in fruit trees (MIAF) could serve as alternatives. Systems that

value traditional agriculture, with improvements from modern techniques like conservation agriculture, are advancements that center small-scale farms (Fernandez et al. 2017). It remains in question how continued modification of maize will impact indigenous seeds from small-scale farms, but it may arguably reduce native seed biodiversity, and, along with it, traditional maize production (Orozco-Ramírez et al. 2017). Either way, both initiatives are necessary for each farming scale to participate in the market and promote food security.

Mexico's Agriculture Sectoral Plan for 2019-2024, which uses over half of its investments on food security and transnational financing, has allowed for mitigation and sustainability projects in forested areas (World 2015). Through 2020 and 2021, Mexico's Congress restructured the financing and administration of programs such as the National Financing of Agricultural Development (FND), which would merge credit granting, insurance, and project financing. For agriculture and rural development, there are three focus areas to improve: self-sufficiency, poverty, and producer income through programs like Sowing Life and area-based payments. However, loopholes exist in these programs, in that sometimes producers are incentivized to deforest an area and replant with the help of Sowing Life (OECD 2020). With transnational support through the Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative, CONAFOR can collaborate with state and local governments. Many states with high indigenous populations such as Oaxaca, Yucatan, and Quintana Roo now have established REDD+ projects that promote production without deforestation (Alianza 2022). The complexity of such multi-level policies creates transparency and representation issues for rural and

indigenous groups, in which the federal government responded with local-based consultations from 2015 to 2017 (Špirić 2018). This underlines the challenges of implementing top-down strategies; REDD+ has been subjected to considerable criticism, and further analysis is needed to extrapolate program improvements.

Food security risks from the biofuel industry could further put rural areas in danger, despite the economic benefits of job creation. Transitioning into a low-carbon, fossil fuel economy, in 2012 Mexico was expecting a US$2-4 billion profit in the bioethanol, biodiesel, and bioelectricity industries. This could allow for diversification of income in rural areas that grow biofuel crops (UNCTAD 2013). However, since most first-generation biofuels are produced with sugarcane and corn, this superseded self-sufficiency crops for the rural poor and caused land-use conflicts (Trigo et al. 2015). Second generation biofuels could potentially diminish this problem since they are produced with nonedible biomass such as residual waste or lignocellulosic materials. However, globally there has yet to be a commercially viable second generation conversion process (Kularathne et al. 2019). Similarly in Mexico, second generation biofuels are technologically viable through blue agave, sugarcane bagasse, and corn stubble, but production costs are too high. Viable areas for this industry exist in the Gulf of Mexico and the Pacific regions. Furthermore, as a developing country, Mexico would need to ensure biofuel producers have equal access and competitiveness in the global economy, but the institutional framework and fiscal policy is not developed enough (Bautista-Herrera 2021; Sosa-Rodriguez and Vazquez-Arenas 2021). Nevertheless, second generation biofuels could still have the potential to create jobs, reduce greenhouse

gas emissions, and advance renewable energy sources, but not at the expense of rural land.

Steps to be taken nationally to prepare for climate change's uncertainty are weather advisory reports for producers, especially for droughts and frosts, insurance protections against adverse environmental events, and seedbanks. Regional reports would allow farmers to prepare for inclement weather through protective or conservation practices. The project "Masagro Movil" is an example of a weather and price database to enhance farmer knowledge. The monitoring system around the Observatory of the Maya Forest (OSM) in the Yucatán Peninsula also provides monitoring of forest threats, along with a Productive Zoning Map, which local stakeholders can utilize for land-use planning (Alianza 2022). Insurance protections for the producer now exist through the National Organism for the Integration of Insurance Funds (OINFA) and AGROASEMEX. According to CIMMYT, almost 30 percent of farmers have insurance, but efforts to expand access are crucial for the future (World 2015). These are a few safeguard rural producers can take to prepare for and protect against the uncertainty of climate change.

Chapter 11: CONCLUSION

Mexico has prospective policies that could significantly improve the livelihoods of the rural poor and indigenous people, while preparing for the climate crisis and the inevitable consequences of migration and disasters. The National Development Plan of 2019-2024 highlights several sustainability objectives; inequality reduction initiatives, and institutional improvements for economic, social, and political welfare (SEGOB 2019). The current administration seems determined to promote the prosperity of both the people and the environment. By forming new commission and program initiatives, Mexico can continue to learn from past policy errors and limitations to improve their 2024 and 2030 plans. Although the political commitment for change is present, the capacity and resources to reach future goals is constrained. These obstacles prevent Mexico from following through with promises made on the international stage, especially when it comes to climate change. Without large-scale national, state, and local policies that focus on poverty alleviation and employment opportunities for this targeted group, they will continue to suffer the consequential burdens of climate change. Through involvement of multi-level entities from the local to the international, collaborations with NGOs, academic researchers, and development assistance agencies, Mexico has the possibility to minimize the damage of the climate crisis.

As one of the top ten food producing countries in the world, Mexico must adapt to challenges of food insecurity, while prioritizing its domestic consumers. Although several examples throughout this thesis described cases in which agro-exports surpass domestic

production, small-scale producers exist as possible solutions to food insecurity on a local level. This would be dependent on regional development needs, for which certain capabilities are limited by topography, infrastructure, and labor. Medium-to large-scale farmers should also prosper, but not at the expense of small-scale farming. Focusing efforts on carefully targeted populations whether it is small-scale farmers, the rural poor, and/or indigenous people would allow a program to achieve greater success. These programs must cater alternative forms of agriculture to rural areas such as climate-smart techniques, expanded agroforestry and organic certification, and improved indigenous systems that could create market opportunities on a local level. At the same time, sustainability programs could promote short and long term goals against the climate crisis. Strategies that prioritize the welfare of these communities are essential for alleviating poverty and inequality across the country.

Table 1: Mexican States Population Demographics

State	Total Population 2019	GDP per capita	Percent Indigen-ous Pop 2015	Percent Emigrant Population 2020	Percent Indigenous Language	Percent Rural Population 2020	Percent Poverty 2018	Percent Extreme Poverty 2018	Level of Education 2020
Aguascalientes	1,425,607	214,835	11.7	6.2	0.3	16	26.2	1.2	10.3
Baja California	3,769,020	214,003	8.5	7.7	1.5	6	23.3	1.6	10.2
Baja California Sur	789,447	272,719	14.5	11.7	1.5	9	18.1	1.5	10.3
Campeche	928,363	672,829	44.5	4.4	11.5	25	46.2	9.8	9.6
Chiapas	5,543,828	59,756	36.1	3	27.9	51	76.4	29.7	7.8
Chihuahua	3,741,869	212,975	7.3	4.7	2.7	13	26.3	2.6	10
Cuidad de México	9,209,944	401,566	8.8	7.4	1.5	N/A	30.6	1.7	11.5
Coahuila de Zaragoza	3,146,771	270,986	6.9	4.6	0.2	8	22.5	1.4	10.4
Colima	731,391	200,995	20.4	8.1	0.6	10	30.9	2.4	10
Durango	1,832,650	150,331	7.9	4.1	2.4	28	37.3	2.2	9.7
Guanajuato	6,166,934	157,641	9.1	3.3	0.2	28	43.4	4.2	9
Guerrero	3,540,685	88,946	33.9	3.8	15.3	40	66.5	26.8	8.4
Hidalgo	3,082,841	122,892	36.2	8.7	14.2	43	43.8	6.1	9.4
Jalisco	8,348,151	196,634	11.1	6.9	0.8	12	28.4	3	9.9
Estado de Mexico	16,992,418	119,357	17.0	5.8	2.7	13	42.7	4.9	10.1
Michoacán de Ocampo	4,748,846	119,913	27.7	4.4	3.6	29	46	6.1	8.6
Morelos	1,971,520	128,481	28.1	7.3	2	18	50.8	7.4	9.8
Nayarit	1,235,456	130,592	22.2	7.7	5.4	28	34.8	5.9	9.7
Nuevo Leon	5,784,442	319,062	6.9	11.8	1.2	N/A	14.5	0.5	10.7
Oaxaca	4,132,148	84,200	65.7	6.2	32.2	51	66.4	23.3	8.1
Puebla	6,583,278	116,299	35.3	4.8	11.3	27	58.9	8.6	9.2
Queretaro	2,368,467	225,049	19.2	11.3	1.7	21	27.6	2	10.5
Quintana Roo	1,857,985	201,600	44.4	13.2	16.6	10	27.6	3.5	10.2
San Luis Potosi	2,822,255	184,774	23.2	4.5	10	33	43.4	7.3	9.6
Sinaloa	3,026,943	170,651	12.8	4.4	1.4	24	30.9	2.7	10.2
Sonora	2,944,840	262,726	17.8	5.3	2.4	12	28.2	2.6	10.4
Tabasco	2,402,598	216,705	25.8	2.9	2.7	41	53.6	12.3	9.7
Tamaulipas	3,527,735	201,260	6.3	5	0.7	10	35.1	3.3	10.1
Tlaxcala	1,342,977	101,684	25.2	5.5	2.7	17	48.4	3.1	9.8
Veracruz	8,062,579	128,820	29.3	4.3	9.2	38	61.8	17.7	8.7
Yucatan	2,320,898	149,831	65.4	6.7	28.9	14	40.8	6.7	9.6
Zacatecas	1,622,138	127,019	7.6	4.6	0.3	37	46.8	3.4	9.2

Table 2: Predicted logGDP per capita, Percent Poverty, and Percent Emigrant by Mexican States

State	logGDP per capita	Predicted logGDP per capita	Difference logGDP per capita	logGDP per capita Success/Failure	Predicted Percent Poverty	Difference Percent Poverty	Percent Poverty Success/Failure	Predicted Percent Emigration	Difference Percent Emigrants	More/Less Predicted Percent Emigrants
Aguascalientes	12.28	12.33	0.05	Failure	30.98	4.78	Success	7.49	1.29	Less
Baja California	12.27	12.22	-0.05	Success	22.99	-0.31	Failure	7.75	0.05	Less
Baja California Sur	12.52	12.19	-0.32	Success	15.82	-2.28	Failure	8.96	-2.74	More
Campeche	13.42	12.14	-1.27	Success	38.12	-8.08	Failure	5.18	0.78	Less
Chiapas	11.00	11.16	0.16	Failure	71.69	-4.71	Failure	2.06	-0.94	More
Chihuahua	12.27	12.19	-0.08	Success	31.42	5.12	Success	7.07	2.37	Less
Cuidad de México	12.90	12.94	0.04	Failure	15.27	-15.33	Failure	5.51	-1.89	More
Coahuila de Zaragoza	12.51	12.41	-0.10	Success	27.19	4.69	Success	7.42	2.82	Less
Colima	12.21	12.15	-0.06	Success	28.35	-2.55	Failure	7.51	-0.59	More
Durango	11.92	12.04	0.12	Failure	42.10	4.80	Success	5.53	1.43	Less
Guanajuato	11.97	11.69	-0.28	Success	43.64	0.24	Success	4.42	1.12	Less
Guerrero	11.40	11.46	0.06	Failure	61.18	-5.32	Failure	3.17	-0.63	More
Hidalgo	11.72	11.88	0.16	Failure	50.19	6.39	Success	7.24	-1.46	More
Jalisco	12.19	12.09	-0.10	Success	28.65	0.25	Success	7.14	0.24	Less
Estado de Mexico	11.69	12.26	0.57	Failure	38.03	-4.67	Failure	5.69	-0.11	More
Michoacán de Ocampo	11.69	11.52	-0.17	Success	50.69	4.69	Success	6.06	1.66	Less
Morelos	11.76	12.10	0.34	Failure	40.00	-10.80	Failure	5.09	-2.21	More
Nayarit	11.78	12.01	0.23	Failure	41.01	6.21	Success	7.54	-0.16	More
Nuevo Leon	12.67	12.38	-0.30	Success	8.02	-6.48	Failure	8.71	-3.09	More
Oaxaca	11.34	11.37	0.03	Failure	71.87	5.47	Success	6.25	0.05	Less
Puebla	11.66	11.87	0.21	Failure	51.93	-6.97	Failure	4.37	-0.43	More
Queretaro	12.32	12.33	0.01	Failure	24.78	-2.82	Failure	7.87	-3.43	More
Quintana Roo	12.21	12.23	0.02	Failure	26.12	-1.48	Failure	10.38	-2.82	More
San Luis Potosi	12.13	12.05	-0.08	Success	46.40	3.00	Success	5.52	1.02	Less
Sinaloa	12.05	12.33	0.28	Failure	40.33	9.43	Success	7.03	2.63	Less
Sonora	12.48	12.44	-0.04	Success	31.31	3.11	Success	7.41	2.11	Less
Tabasco	12.29	12.16	-0.13	Success	52.10	-1.50	Failure	3.61	0.71	Less
Tamaulipas	12.21	12.23	0.02	Success	29.84	-5.26	Failure	5.39	0.39	Less
Tlaxcala	11.53	12.14	0.61	Failure	44.50	-3.90	Failure	5.60	0.10	Less
Veracruz	11.77	11.59	-0.18	Success	54.28	-7.52	Failure	3.11	-1.19	More
Yucatan	11.92	12.17	0.26	Failure	50.62	9.82	Success	10.26	3.56	Less
Zacatecas	11.75	11.76	0.00	Success	46.17	-0.63	Failure	3.94	-0.66	More

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